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POWER

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The A. S. M. E. Fiftieth Anniversary

ON FEBRUARY 16, fifty years ago, a little group met at the office of the *American Machinist* and decided to organize the mechanical engineers of America.

The Institution of Mechanical Engineers had been organized in England thirty-three years before, but in this country the American Society of Civil Engineers was the only professional engineering organization.

There were practicing mechanical engineers aplenty but they were regarded as hardly in the professional class. The first university to establish a course in mechanical engineering was Yale. This was in 1856. Several other engineering schools were in existence by 1880, but the number of engineering graduates was small.

This week the A.S.M.E., which has become one of the leading professional societies of the world, celebrates the fiftieth anniversary of its organization.

The New York program includes a luncheon at the present offices of the *American Machinst*, a pageant in the Auditorium of Stevens Institute, where the organization meeting was held on April 7, 1880; a welcoming dinner by the Metropolitan Section; and, on Sunday, commemorative services at the Cathedral of St. John the Divine.

The scene then shifts to Washington as the place that is fittingly in accord with the national and international character of the convocation. Here will be received the greetings of the engineers of the world in brief addresses by delegates of the dozen or more countries represented and by the presidents of American sister societies.

President Hoover, himself an honorary member of the A.S.M.E., will receive the society and its guests at the White House. Other receptions, luncheons and dinners, the bestowal of honors, brief summaries of national thought by its best exponents from different countries on the influence of engineering upon civilization, and summaries of progress and achievement in mechanical engineering during the half century compiled by the professional divisions of the society will constitute a fitting ceremonial background to the brilliant assemblage that will gather to celebrate the completion of fifty years of useful existence.

John Sweet, the father of the A.S.M.E., arguing against the exclusion of the practical by the academic, said that the time would come when the man who knows what to do and how to do it will be esteemed at least as highly as he who knows only what has been done and who did it.

Out of the past, evoked by these associations and ceremonies, will come the commanding figures of those who built mechanics into history to receive the recognition due to achievement in the formative stages of the profession.

May the centennial of the society present an equally creditable record of progress and accomplishment.

F. R. Low

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EDITORIALS

Great Days Ahead

ALL POWER to the pioneers! How wonderful it is that, in all things, there are people who irk at the commonplace and find their inspiration in breaking trail.

The group at Hartford which undertook to demonstrate the mercury boiler is surely of hardy pioneer stock. There have been tribulations and discouragements aplenty in learning how to handle mercury at the required high pressures and temperatures. The unexpected happened time and again, only to be unfalteringly met and conquered until rewarded by success.

Recent reports record an extended period of successful operation with gratifying fuel economy and a simplicity of control which is fully up to expectation.

At that, the mercury boiler is but one of the accomplishments in the rapidly changing power practice.

Research is active in many directions. Boilers which generate steam at 3,200 pounds are in practical operation. High-temperature-resistant metals are being developed. Turbine capacities and efficiencies are increasing, and so on through all the equipment known to the art big things are being accomplished.

In June engineers of all the leading countries of the world will exchange ideas upon power at the World Power Conference in Berlin.

Never before has the field of power production been so surcharged with the big things to come, nor has the pioneer spirit been more evident. What an age to live in!

The Main Function Of Water Walls

THE QUESTION has been asked whether water-cooled walls are placed in furnaces to protect the wall refractories or to increase the radiant-heat-absorbing surfaces of boilers. The answer is that such walls have been added for both purposes.

The first water-cooling added to the bottom of the furnace at Oneida Station, Milwaukee, was wholly for the protection of the refractories. The water-cooling tubes in the Lakeside, Cahokia, and several other early pulverized-coal furnaces were also primarily for the protection of the furnace wall refractories, and, incidentally, added radiant-heat-absorbing surface.

Water-cooled side walls, now quite generally added along the clinkering zone and on the bridge walls of stoker furnaces, are fundamentally to protect the furnace walls rather than to increase boiler surface.

However, in the case of the Woods steam generator and other similar boilers, the water-cooled walls actually form the complete furnace inclosure and at the same time constitute a considerable portion of the heating surface of the boiler. Hence such surfaces are obviously intended to serve as extended radiant-heat absorbing areas and as wall surface.

Apparently while such water-cooling was originally added to furnaces to protect the wall refractories, the later trend is toward its installation as added surface for the absorption of radiant heat.

Hydro Developments in Europe and America

IN THIS number the designs of two low-head European hydro-electric plants are described. Propeller type waterwheels are used and they are the largest in diameter and power so far constructed. However, the five units in Kembs plant, rated at thirty-six thousand horsepower under a fifty-four-foot head, will be exceeded by six units under construction for the Seven Sisters Falls project in Canada. These are rated at thirty-seven thousand five hundred horsepower under a sixty-six-foot head. Two large plants are now in operation in Canada with units of about thirty thousand horsepower under a sixty-foot head.

As both of the European plants use baffles in the draft tubes, they appear to violate some of the ideas in draft-tube design. Tests made on models in this country have shown that such baffles are detrimental to efficiency. It was evident from these tests that baffles could be so placed as to improve the efficiency at one point on the

curve, but at others the performance is not so good as without the baffles. At the Raanaasfoss plan in Norway three large units were installed without baffles in the draft-tubes and three with them. The latter, on test, fell down badly in efficiency. Recently the manufacturer of the runners made an exhaustive series of tests that led to the removal of the draft-tube baffles. This and other changes improved the maximum efficiency five per cent. The opinion is generally held in this country that if a draft tube is properly designed no benefit can be obtained from a baffle. In view of these conflicting practices, the test results on the units in question will be looked forward to with interest.

Laboratory tests were used extensively in the design work on the two European plants. The waterwheel manufacturer built models of the runners and their setting and tested them for the Ryborg-Schworstadt plant. At the technical university at Karlsruhe a model was made of the river section where the proposed plant was to be located, and the necessary tests made. When all data were available, the different interests co-operated in the final design of the plant.

Lack of such model testing in this country has frequently been emphasized. There is good reason to believe, however, that this condition is rapidly being rectified. The large waterwheel manufacturers have their own laboratories, and in the hydraulic laboratories at some of the universities model tests are being made.

Just "Getting By"

RECENTLY the engineer in charge of the power plant of a dye house approached the management with a well-worked-out plan for a new plant to replace nineteen small boilers and obsolete generating equipment. The boilers were scattered in various parts of the plant and several had been condemned by the boiler inspector. Part of the generating equipment could not be used, and most of the power was purchased.

The engineer explained to the management that were a new plant installed, all power could be generated and the heat in the exhaust used for heating water; the new boilers would be more efficient; labor costs would be reduced; and the plant would pay for itself out of savings in three or four years. The management remarked: "You 'got by' last year. Can you 'get by' this year?" Upon answering "yes" the engineer's plea for a new plant was refused.

Such a management policy is near-sighted. The old boilers must some time be replaced, and delay represents an actual loss. But this is not all—the plant that just "gets by" will some day fail. When production stops, the operating cost mounts rapidly. The power plant that just "gets by" is a liability, a constant source of worry, and often dangerous.

Efficiency of Crankcase Compression Diesels

AT TIMES engineers are inclined to avoid simplicity of design, feeling, no doubt, that efficiency is obtainable only with complicated mechanisms. This, probably, is the reason that the crankcase-compression two-stroke-cycle oil engine has received some criticism from engineers who insist on viewing a machine on the basis of inherited prejudice rather than on its performances. Frequently the statement is made that this type of engine cannot show as low a fuel consumption as will a four-stroke-cycle engine, for, it is pointed out, the brake output per unit of cylinder volume is low, especially with a pre-combustion cylinder head. The assumption is then made that the fuel consumption must be high, as combustion is incomplete and much heat is lost in the exhaust gases.

Tests on an engine of this type discussed elsewhere in this number prove that this line of reasoning is groundless. The units displayed an excellent fuel consumption, which should be expected when the peculiarities of this type of engine are taken into consideration.

Theoretically, a Diesel engine shows an improvement in indicated efficiency as the cutoff is decreased; in other words, as the ratio of fuel to the cylinder air charge is decreased. True, the crankcase-compression engine does not remove all of the burned gases of the previous combustion; but the theoretical efficiency depends upon the ratio of fuel to cylinder gas mixture, not its ratio to the charge of oxygen. Consequently, the limited amount of fuel that can be burned per unit of cylinder volume, while decreasing the power output, actually serves to give a high efficiency.

The mechanical efficiency of such an engine is higher than that of a four-stroke-cycle engine, which means that on low loads the fuel consumption per brake-horsepower is not so adversely influenced by the mechanical losses. It is true that the large amount of spent gases, due to the high air to fuel ratio, carries much heat away. But to compensate somewhat for that defect the loss to the jacket water is less than in some other types of engines, for the cylinder temperature is lower and radiation losses vary as the fourth power of the combustion temperature.

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6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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View of Delray boiler, showing operating platform and stoker enclosure.

DELRAY BOILERS DEPART FROM PREVIOUS PRACTICE

Separate boiler unit for water walls and an unusually long stoker of new design are features at Detroit Edison station.

By C. S. TURNER
The Detroit Edison Company

IN THE first section of the new Delray[1] plant of the Detroit Edison Company five single-ended Stirling type boilers are in operation. They are a distinct departure from past boiler practice of the company, which has heretofore installed the double or type W Stirling boilers in its power plants.

The different design of boiler in this recent plant reflects a change in certain fundamental conditions rather than dissatisfaction with the double-ended Stirlings previously used.

Some of the objections to the double-ended boiler are the complication of operating arrangements and coal-handling equipment, and the necessity of placing economizers, preheaters and fans directly above the boiler, which results in a high boiler house. Assuming two double-ended boilers per turbine, three firing aisles and three rows of bunkers are required, with cross conveyors for coal distribution. On the other hand, two single-ended boilers per turbine may be arranged with one common firing aisle, one row of bunkers, and simple arrangement of coal conveyors. Economizers and preheaters can be placed behind the boilers, reducing building height and spreading the weight to be carried by the foundations over a larger area.

One of the most apparent disadvantages of the single-ended boiler arrangement is the large concentration of weight in one large bunker over the central aisle. This required a large amount of heavy steel in the supporting structure, and if a mat type of foundation had been used, as originally contemplated, instead of the caisson-to-rock construction finally adopted for the whole plant, the cost of foundations under the bunkers would have been materially increased.

Although factors that led to the choice of the single-ended boiler pointed to lower first cost, subsequent experience indicates that the cost of this boiler plant per unit of capacity is little, if any, less than that of the double-ended arrangement at earlier plants. The only advantage, therefore, of the Delray layout

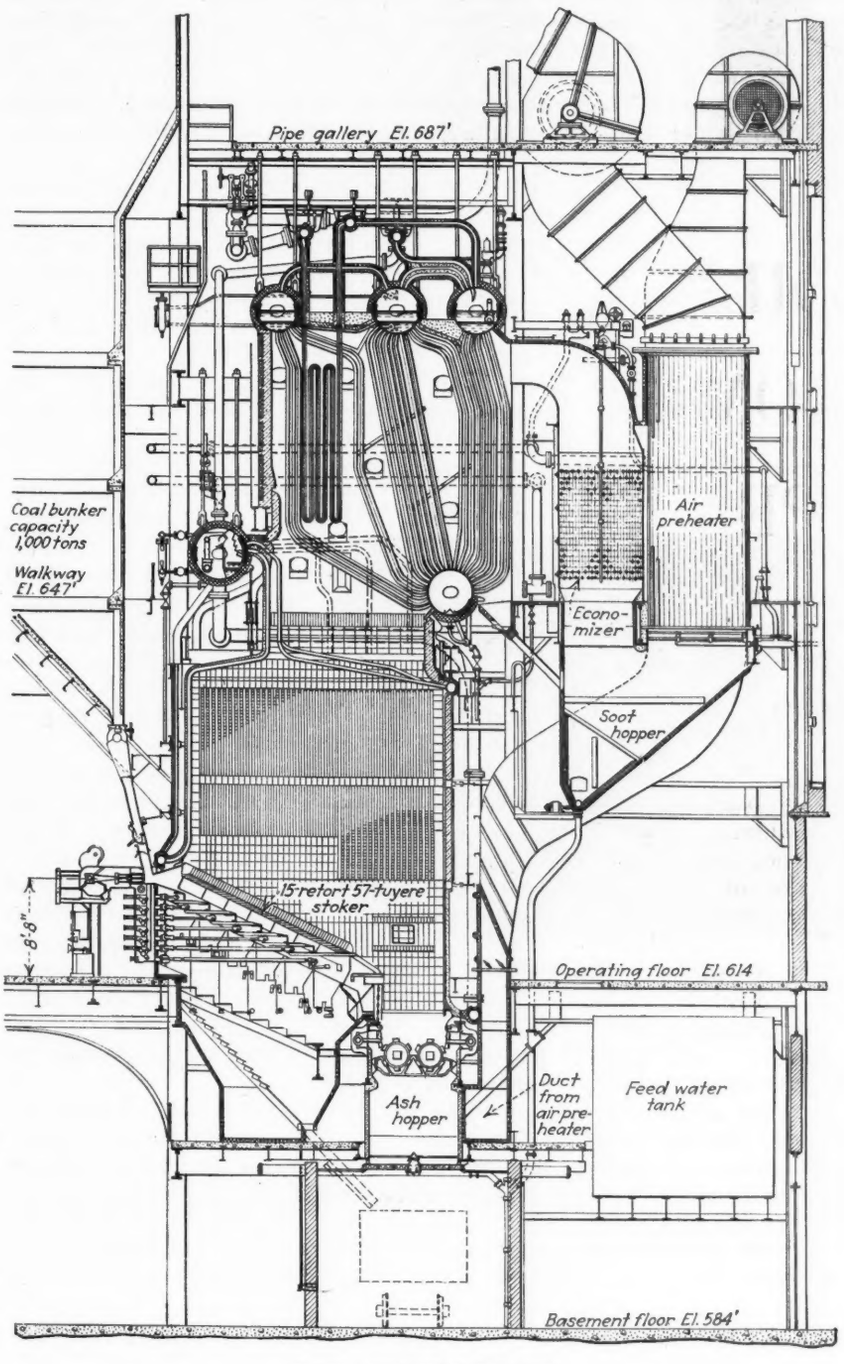
[1] A general description of Delray No. 3 appeared in the Nov. 5, 1929, number of *Power*.

appears to be the operating convenience of having one firing aisle instead of three.

Operating experiences with stokers and pulverized coal had indicated a close comparison between the two types of coal-burning apparatus as to efficiency, and only a negligible difference in capital investment between the two types of equipment as proposed. Developments in stokers and pulverized-coal burning at a future date may make a change highly desirable, and it was found possible and entirely convenient to design a boiler house, boilers and settings adaptable to either method of combustion. Changes which may later become desirable can be made without altering the coal-handling equipment and with minor alterations to boiler settings.

Stokers were decided upon for the initial installation of five boilers. The influencing factor was not difference in efficiency, but ash disposal, ordinarily considered of minor importance. No practical use for the pulverized-coal ash has been found, but the refuse from stokers has a local market as aggregate for cinder concrete. This not only solves the problem of disposal, but brings in a revenue as well. The fly ash discharged from the stacks of a pulverized-coal plant must likewise be taken into consideration in a power station located in a city.

In the installation as contemplated for pulverized coal, no economizers were included, it being considered best economy, with four stages of turbine extraction for feed-water heating, to recover all the available heat in the exit gas in the air preheater. The resulting temperature of preheated air would have approximated 550 deg. This was considered too high for use with stokers, and, accordingly, when stokers were decided upon an economizer was added of size sufficient to reduce the temperature of the air leaving the preheater to 350 deg. at the maximum coal burning rate. The economizer installed contains heating surface amounting to approximately 25 per cent of the main boiler heating surface.



Section through boiler unit

Use of a single-ended boiler necessitated securing a single-ended stoker 57 tuyeres long and 15 retorts wide, this width being dictated by the limitations of boiler drum manufacture. A stoker length of 57 tuyeres, particularly with preheated air, raised many operating questions. A fuel bed of this size cannot be worked with slice bars, yet holes in the fire must be eliminated. Even the 21- and the 29-tuyere stokers of the company's previous experience had called for successive stages of air control from front to back for best results. Here something additional was needed, so experimental installations of zoned air control were made by the stoker manufacturer at the Marysville plant several months previous to the Delray installation. Later this experimental work was shifted to Delray.

Apparently, some form of dampering is needed, with provision made not only for the control of the air to successive zones of combustion from front wall to ash pit, but also for fifteen divisions laterally, one for each retort. Whether this degree of air control can be made automatic or not remains to be demonstrated.

In this stoker there are six pushers for each retort, in addition to the moving extension grate and ram. Provision is made for independent adjustment of each pusher from the front outside of the air chamber. As mounted, the rams are approximately 9 ft. above the operating floor, necessitating an operating platform to give access to the gear boxes. The platform has been elaborated to provide an inclosure around the stoker, the front inclosing wall also forming the boiler gage board.

The Delray boiler unit consists of two separate boilers operating inde-

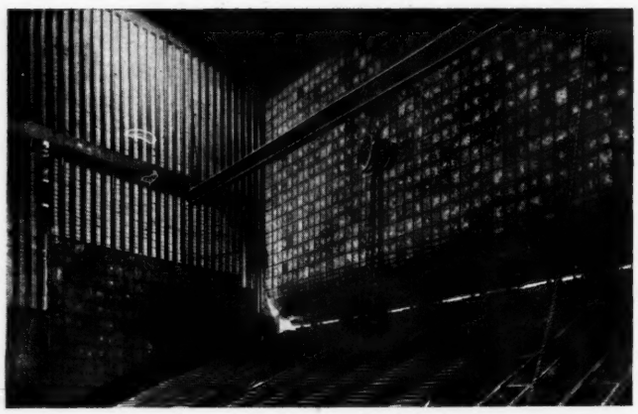
pendently, but connected in series. The screen boiler, which is arranged so that the tubes completely surround the furnace, has its own steam drum, water columns, dry pipes, steam discharge main and non-return valves and feed-water regulation. Though separately fed, it discharges its steam into the main boiler, located directly above, from which the steam passes through a common superheater into the distributing mains.

As designed, the water within the screen boiler circulates in three different ways. Front-wall-screen circulation is effected through rows of downcomer and riser tubes, all terminating in the steam-liberating drum. The rear-wall screen is supplied with water by two 12-in.-diameter external downcomer pipes leaving the bottom of the steam drum at the quarter points and entering the lower header at each end. Riser tubes are distributed in the same manner as in the front screen, all entering the drum.

Side-wall screens could not be so connected to the screen drum and were therefore designed on the recirculation principle. Headers at top and bottom connect with downcomer and riser tubes, recirculation taking place within this unit. Four 4-in. downcomer tubes for each side-wall screen conduct "make-up" water from the steam-liberating drum to the lower header, and wet steam passes from the upper header through six 4-in. riser tubes to the steam drum.

From a combustion standpoint other factors are to be noticed. The front-screen tubes are bent so as to form a Dutch oven over the upper third of the stoker. This sets up a mixing of the richer gas, with the leaner gas formed at the rear of the furnace.

Various tube-covering devices were adopted to temper the cooling effect of the screen at the points where reflected heat is essential to good combustion. All of the front wall is covered with refractory-coated blocks to promote complete combustion of the gas. The upper ends of the rear-wall-screen tubes are extended across the top of the furnace with 12-in. staggered spacing, forming a slag screen through which the gas passes from the furnace to the convection boiler. Above the slag screen there is a brick-lined secondary combustion chamber leading to the main boiler. Rich gas from the front end of the stokers is given opportunity in the secondary chamber to mix with lean gas from the lower end of the stoker for the purpose of completing combustion before entering the main boiler.



Interior of furnace showing trolley used for installing tuyere air distribution boxes

The side walls are covered with bare cast-iron blocks at the slag line, but above this a specially designed brick is fitted between and behind the 3¼-in. furnace wall tubes spaced on 6-in. centers. Refractory extends from the center of the tube back 6 in. and is plastered at the outside with a 2-in. coat of insulating cement. Bricks are held in place by a system of steel bars anchored at intervals of 2 ft. vertically and horizontally by lugs welded to the tubes. The rear wall is covered in the same way as the side walls except that blocks are of the "slag-coating" type, intended to permit a coating of slag to accumulate during service.

The main boiler is a special-design four-drum single Stirling type built for 455-lb. working pressure. Tubes, which have standard Stirling spacing, are 3¼-in. outside diameter. Setting walls for the main boiler are composed of 9 in. of brick backed up with 2½ in. of insulation and an air-tight steel casing.

Built for a discharge pressure of 409 lb. and a temperature of 725 deg., the superheater is radically different from previous installations. Straight-line superheat characteristics were sought by placing the superheater as close to the furnace as safety would permit, thus securing the compensating benefits of radiant heat. There is one row[2] of screen boiler tubes and three rows of main boiler tubes between the superheater and the furnace. A row of tubes, equally distributed, connects the boiler drum and the superheater inlet header, thus effecting perfect entrance distribution. There are 52 superheater tubes, spaced 6-in. apart. Each is built up of tubes welded together to form the length necessary for required heating surface. Headers are located entirely outside of the boiler setting, for ease of support and accessibility to handholes.

The economizer is of the bolted-joint, forged, return-bend type, with 2-in. outside diameter bare tubes. One vertical row of tubes is left out at the center for four soot blower elements, which are operated from above. Cast-iron supporting plates at each end of the economizer are sectionalized and provided with packing glands for each tube hole to prevent gas leakage through the ends of the casing. The side wall on the boiler side, and also the rear wall of the boiler, are uninsulated steel plates, the space between boiler and economizer setting being closed and insulated at the ends flush with the end walls of the boiler, economizer and preheater, forming an unbroken wall line for the entire unit.

From the economizer gas is conducted to the preheater through a hopper common to both, which provides a low-velocity chamber for soot elimination. The lower part of this hopper is lined with paving brick and has a motor-driven screw conveyor and soot discharge pipe through which soot is carried to the ash pit. The floor of the hopper directly under the preheater opens downward to provide for preheater tube replacement.

The preheater casing is rectangular in form and contains 1,920 closely packed straight tubes expanded tightly into top and bottom tube sheets. Expansion is taken care of by a bellows joint in the casing just under the top tube sheet. Gas passes straight through from bottom to top, but air flow is split, half coming from each of two forced-draft fans. It enters at the ends,

[2]This one row is staggered in such manner as to appear as two rows in the illustration.

flows horizontally toward the center, horizontally back to the ends, and thence downward past the ends of the soot hopper to join in a common duct behind the boiler, through which it passes to the stoker plenum chamber. Normally, flue gas is reduced to 350 deg., and air is preheated to about the same temperature.

Two forced-draft fans, driven at variable speed from a common motor, were selected particularly for their characteristics in parallel operation. They are designed to operate at a maximum of 12-in. static pressure. By-pass dampers will supply cold air to facilitate inspection and maintenance of the stoker under continuous operating conditions. Solenoid-operated shut-off dampers immediately below the fans automatically close when the fans are shut down, thus preventing hot air from backing up into them.

Mounted on the same floor are the induced-draft fans, which discharge into a long, straight duct leading to the stack. The duct is designed for approximately complete recovery of the high-velocity energy of the fan discharge. The fans provide a static pressure difference of 12 in. with 350 deg. F. gas.

For a number of months the new plant has been assigned its regular share of the load. Performance of the boilers has been quite satisfactory, circulation of gas, steam and water working out as designed. Some adjustments to the superheater have been necessary to produce the required temperature, and work is still going on with the arrangement and adjustment of the stoker air control. These and other minor adjustments are no more than was expected in getting equipment of this type in operating order.

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A Simple Method of Computing Tensile Strength of Wire

By H. M. Friend
New York City

FOR THOSE who inspect and test wire and cable there is a slide-rule method of computing tensile strength whereby, given the diameter of the sample and the pounds at which it breaks, the tensile strength in pounds per square inch may be obtained by one setting of the slide rule. This is considerable saving in effort over the usual method of first computing the wire's or rod's cross-sectional area in square inches and then dividing the pounds required to break the sample by its area. Using the simplified method, set on scale D of the slide rule the diameter of the wire or rod under test. Over this point set the constant 1.13 on scale C; then on either of the two halves of A scales set the pounds at which the sample broke. The answer will appear on scale B directly under the setting on scale A.

As an example, take a bare copper wire having a diameter of 0.116 in. Assume that this wire when tested broke at 720 lb. Ordinarily, the cross-sectional area of the wire would be calculated by the formula: Area $A = 0.7854$, $D^2 = 0.7854 \times 0.116 \times 0.116 = 0.0106$ sq.in. This requires one setting of the slide rule. The pounds to break (720) is divided by 0.0106, requiring a second operation on the slide rule, and the answer is 68,000 lb. per square inch. To use this simplified method of calculation, the diameter of the wire, 0.116 in., is set on the D scale. Over this on the C scale is set the constant, 1.13. Find the load, 720, on the A scale and the answer, in pounds per square inch (68,000), is read directly below it on the B scale, as indicated in the figure.

Wire tensile strength problem set on the slide rule

All of this was performed on one setting of the slide rule. The settings are indicated by vertical lines in the figure.

For the same diameter of wire and different loads to break the sample, the pounds per square inch can be obtained without moving the slide rule: simply locate the pounds to break on the A scale and read the pounds per square inch on the B scale.

In practice, when a large number of tests have been made all of those readings for the same diameter of wire are computed. Then the setting of the slide rule is changed for the next diameter of wire.

The constant which enters into these computations is 1.13. Some companies use 3.57 and obtain the same results. How this can be is readily seen, since 1.13 is the square root of 1.275 and 3.57 the square root of 12.75, the same grouping of figures with the decimal point one place farther to the right. The mathematical proof for constant 1.13 is simply:

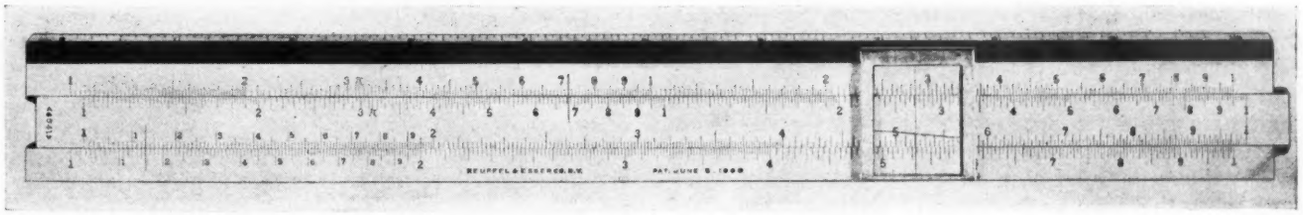
Let P = Pounds required to break a wire.
A = Its cross-sectional area in square inches.
D = The wire's diameter in inches.

$$\text{Then pounds per square inch} = \frac{P}{A} = \frac{P}{0.7854\ D^2} =$$

$$\frac{P}{(D \times \sqrt{0.7854})^2} = \frac{P}{(D \times 0.887)^2} = \frac{P}{\left(D \times \frac{1}{1.1275}\right)^2}$$

The latter is the form that is used. The diameter of the wire is divided by the constant 1.1275 (1.13) and the result squared by transferring it to the A scale. Then P is divided by this value by locating P on the A scale and reading the answer directly below it on the B scale.

It is suggested that the constant 1.13 or 3.57 be scratched on the C scale to facilitate its use. The writer does not claim to be the originator of this method, but he found it useful and was interested in how the above constants were obtained.



Do You Select

INDUCTION MOTOR CONTROL

by Tradition?

By H. H. WATSON
Industrial Control Engineering Dept.
General Electric Company

Recent improvements in induction motors and their control have revolutionized some old-established ideas. In this article the importance of the proper type of control for induction motors is emphasized, and how to select correct control is explained, taking into consideration modern developments

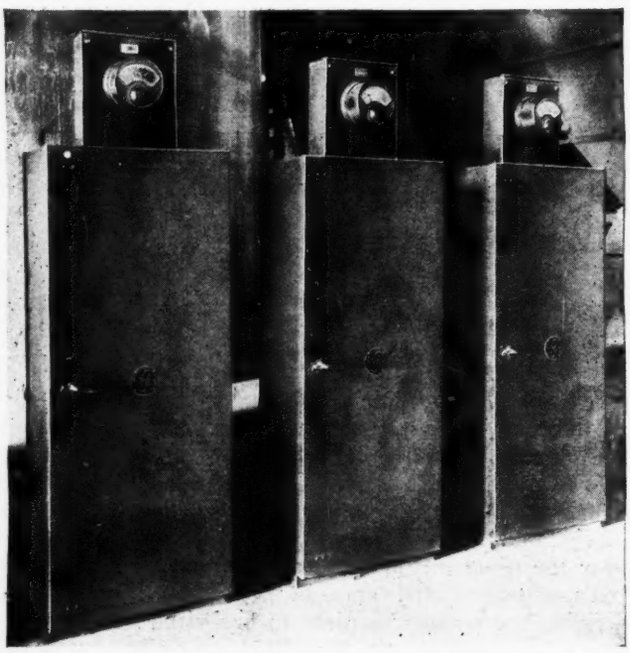


Fig. 1—Pump motor magnetic control inclosed and provided with ammeters

IT IS not necessary to stress the advantages of induction motors, for their simplicity and reliability is common knowledge. Unfortunately, because of improper control, these desirable qualities of the induction motor are not always used to the greatest advantage. Squirrel-cage and slip-ring motors run at practically constant speed between no load and maximum load. Any deviation from this performance is obtained by the use of some device outside the motor. Variations in starting conditions—adjustment of starting torque; starting current and speed; and protection against overloads or other irregularities—have to be provided for externally to the motor and are functions of the control equipment.

Control requirements for induction motors may be classified as: (1) Infrequent starting without load; (2) frequent starting without load; (3) infrequent starting under load; (4) frequent starting under load; (5) intermittent motor load; (6) adjustable-speed and multi-speed motors; (7) restrictions on the current drawn from the line during starting period; (8) low starting torque to avoid damaging the driven machinery; and (9) heavy starting torque.

Control for induction motors cannot be selected without taking cognizance of certain characteristics of the motors. Intelligent selection of a motor may mean a more simple control and a lower cost for the complete equipment.

The preferred method of starting squirrel-cage induction motors is to connect them to full-line voltage. Most motors for operation on 600 volts or below, and many high-voltage motors, are being built with the end windings so braced that they may be started on full voltage. This reduces the total heat produced in the motor windings below that of other methods of starting. There are locations where current that may be taken from the power systems is so limited that full-voltage starting cannot be utilized. In some applications the motor's starting torque at full voltage is too great for the connected load. Many of the latter, however, are more traditional than real, inherited from the time when induction motors had to be started on reduced voltage to protect them.

Where full-voltage starting of squirrel-cage motors cannot be applied, the most generally used starter is the well-known compensator to give reduced voltage at the motor terminals. The compensator has the advantage that reduced voltage is obtained from a transformer, consequently the power losses are small. It is also readily adapted to magnetic control, requiring only a line contactor, a starting contactor and the necessary overload and accelerating relays. An objection raised against the compensator is that during the change from starting to running voltage the motor is disconnected from the auto-transformer before it is connected directly to the line. This sometimes causes a second current inrush that, for a half cycle, reaches a value equal to the initial inrush. However, this is a transient phenomenon of short duration and does not appear as a torque peak. The principal objection to it is that it may cause flickering of lights that are on the same circuit as the motor.

Series resistance is used to a considerable extent to obtain reduced voltage at the motor terminals. The inrush current causes a voltage drop through the resistance. As the motor's speed increases and the current decreases, the voltage drop across the resistance also decreases and the voltage increases at the motor terminals. The major objection to the resistor starter is that it is essentially an energy-dissipating device. If it is made comparable in capacity to the transformer-type starter, its cost becomes excessive.

The size of the motor influences the control selected. Manual controllers for small motors can be operated a considerable number of times without fatiguing the operator. As motor sizes increase controller sizes increase until they cannot frequently be manipulated manually without undue effort. At this point magnetic control or semi-magnetic control becomes desirable, the latter being a combination of the manual and magnetic.

Another factor influencing control selection is the service required of the motor and of the controller, which do not necessarily coincide. For example, a motor started infrequently under unloaded conditions may be subjected to heavy overloads in normal operation, but the control's duty is starting the unloaded motor. On the other hand, there are motors that carry their rated loads for short periods only, but require frequent starting and stopping. This is a converse example of the preceding one and represents heavy duty for the control. Many operators and application engineers do not appreciate this lack of coherence between the severity of service imposed upon the motor and the control. As a result, often expensive magnetic control is installed where a simple manual device would be satisfactory. There are also numerous installations of manual control where a push-button magnetic starter would be a more desirable device.

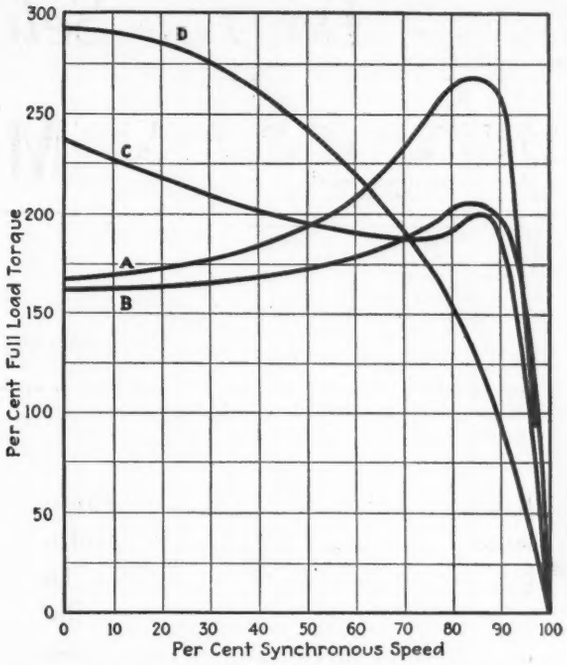


FIG. 3—SPEED-TORQUE CURVES FOR AVERAGE 1,200-R.P.M., 75 to 50-HP. SQUIRREL-CAGE MOTORS

A—Standard squirrel-cage motors, normal starting current. B—Normal-torque, high-reactance rotor, low starting current. C—High-torque, high-reactance rotor, low starting current. D—High-torque high-resistance rotor, low starting current.

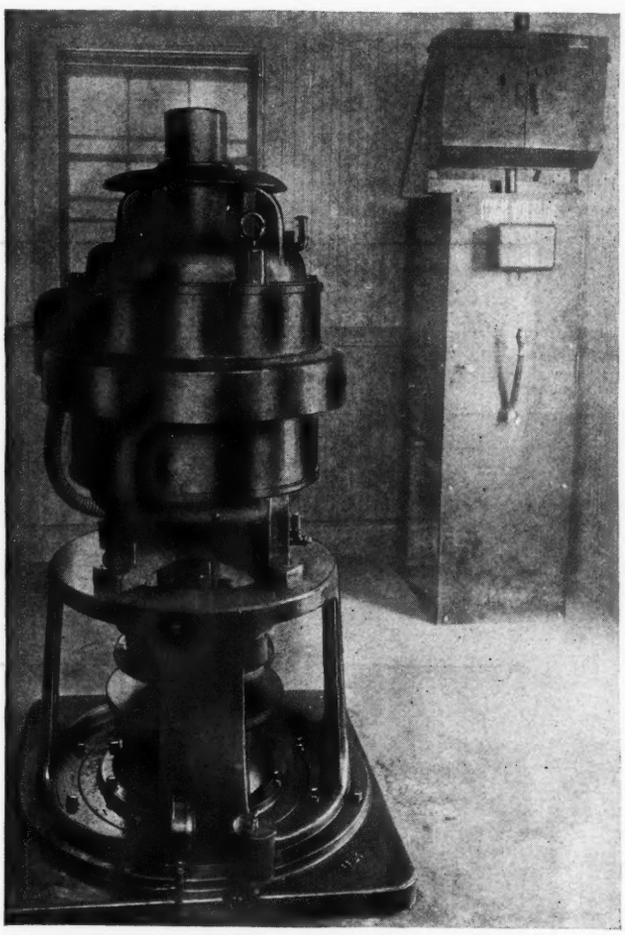


Fig. 2—High-voltage oil-immersed manual compensator for 75-hp. deep-well pump motor

Space does not permit consideration here of all the types of induction-motor applications, but the following will cover the majority of cases.

1. Infrequent Starting Under No Load—Where a motor is started once or twice a day under no load, a manual-type controller will probably be the most desirable. This recommendation is on the assumption that the advantages of remote magnetic control are not desired. A typical example is a machine shop lineshaft that is started in the morning and in the afternoon before work is begun.

2. Frequent Starting Under No Loads—Probably more induction motors are started frequently under light load than under any other condition. Frequent starting may be anything from jogging service, the extreme case of frequent starting, to starting once or twice an hour. A good example of this type of application is that of machine tools with individual drive. These tools seldom cause full load on the motor at starting. The number of operations may vary from the occasional starting of a drill press in an automobile repair shop, to three or four starts a minute on tools used on some mass-production process. A magnetic controller operated from a push-button station or master switch is generally the best type for frequently started motors. With push-button control the operator has only to press a button to correctly start the motor, eliminating the effort necessary to manipulate a manual starter. When the push-button stations are properly located virtually all the operator's attention can be applied to the process.

For Applications 1 and 2 any type of squirrel-cage

motor may be used, because no-load starting eliminates consideration of starting torque.

3. Infrequent Starting Under Load—Starting under load introduces a condition that has to be partially taken care of by the control. Applications requiring starting torques greater than can be obtained with standard squirrel-cage motors can usually be taken care of by squirrel-cage motors having a high-resistance rotor or a high-reactance rotor.

Starting torques developed by different types of squirrel-cage motors at full voltage are shown in Fig. 3. It is not practical to increase, by ordinary methods, the starting torque of a given squirrel-cage motor beyond that available with line voltage applied to the motor terminals. With the wound-rotor induction motor it is possible, by connecting resistance into the rotor circuit, to obtain starting torques up to pull-out value. For infrequent starting under load the use of manual controllers is desirable, but will be influenced by load conditions. Automatic acceleration by magnetic control is preferred for starting a wound-rotor motor under load, as it eliminates the operator in correctly manipulating the controller.

4. Frequent Starting Under Load—What has been said regarding starting torque for infrequent starting under load applies to motors that are started frequently under load. Except for small squirrel-cage motors, in practically every application frequently started under load, a magnetic controller is the desirable type. From the standpoint of reliability, a magnetic controller is the preferable type. The extreme case of frequent starting is jogging service. Across-the-line starters of present-day design will handle repeatedly the inrush currents of stalled motors without showing signs of distress. The small starter, Fig. 4, will handle the inrush current of a 7½-hp., 500-volt squirrel-cage motor 100 times a minute with only slight consumption of the contact-tip material.

5. Intermittent Motor Load—A consideration of intermittently loaded motors focuses attention on the overload protection provided in modern controllers. Maximum safe operating temperature limits the load on any motor. The operating temperature of a motor depends upon the magnitude and duration of the load. Therefore, a device to protect a motor against overloads should duplicate the thermal condition in the motor. A motor starting from room temperature can be jogged against a stalled load several times without overheating; whereas the same motor starting at normal-load temperature may be jogged a few times only until its maximum allowable temperature is reached.

Temperature overload relays include a heating element the temperature of which is proportional to the load current of the motor. The tripping mechanism is calibrated to function when the relay indicates that the motor has attained its maximum safe temperature. With this type of protection it is possible to have the motor carry the maximum safe load. A temperature overload relay allows the motor to operate at any load, including stalling, with assurance of safe protection. For any combination of loads or duty cycles the overload relay will follow the motor's heating and allow maximum

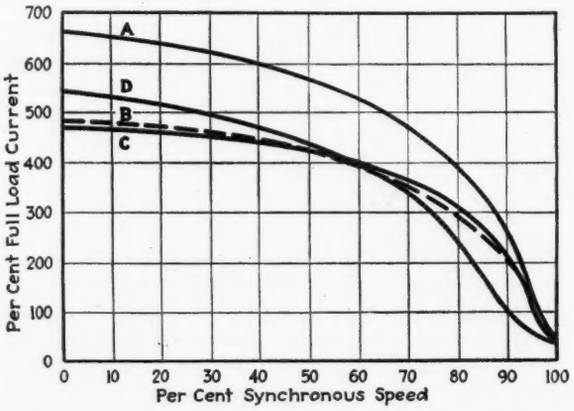


FIG. 6—SPEED-CURRENT CURVES FOR AVERAGE 1,200-R.P.M. SQUIRREL-CAGE MOTOR UP TO 50-HP. RATING

A—Standard squirrel-cage motors, normal starting current. B—Normal-torque high-reactance rotor, low starting current. C—High-torque, high-reactance rotor, low starting current. D—High-torque high-resistance rotor, low starting current.

Fig. 4—Full-voltage starter for 7½-hp. 550-volt squirrel-cage motors

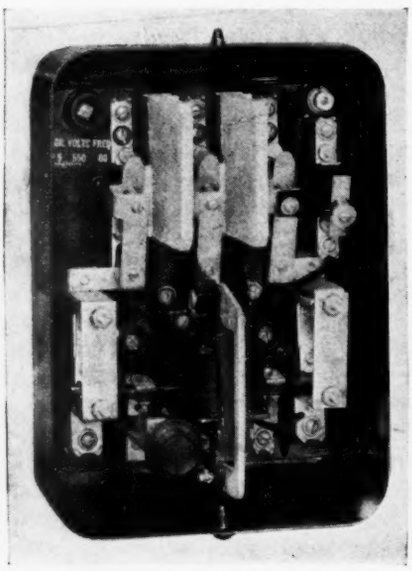
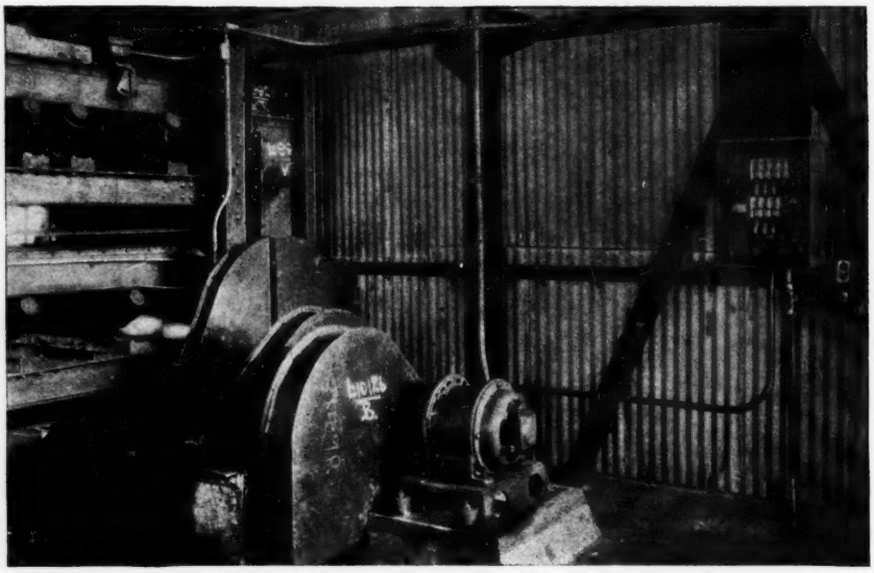


Fig. 5—Squirrel-cage motor with resistor-type magnetic starter on a coal conveyor



output before taking the motor out of service on account of the overload conditions.

6. Adjustable-Speed and Multi-Speed Motors—Many motor applications require adjustable speed. An ordinary squirrel-cage motor is a constant-speed machine, but the multi-speed type is used on many applications where more than one speed is desired. Changes of speed are obtained by using a controller to reconnect the motor windings for different numbers of poles. For this service pole-changing switches, both manual and magnetic, are obtainable.

Altering the amount of resistance in the secondary circuit of a wound-rotor motor permits it to be operated over a considerable range of speed. One example is use of wound-rotor induction motors on adjustable-speed drives for auxiliaries in central stations. Here the line current of the induction motor is handled by a magnetic switch, and the resistance in the motor's secondary is controlled by motor-operated drum switches having as many as 50 speed points. To obtain a constant reduced speed by secondary resistance it is necessary that the motor's load be fairly constant for any one setting of the control.

Fig. 7—Squirrel-cage induction motors and push-button magnetic reversing control operate headgates in hydro-electric power house dam

A number of sewage-disposal plants have recently been designed in which multi-speed squirrel-cage motors are used with pole-changing switches operated from float switches to maintain the level in the sewage tanks fairly constant. It is not essential that the level be kept exactly constant and the variation prevailing with 3 or 4 speeds is satisfactory.

7. Amount of Current Restricted During Starting—As has been previously stated, the ideal method of starting a squirrel-cage motor is to throw it directly on the line at full voltage. There are localities, principally residential districts adjacent to industrial areas, where network distribution systems are used to carry both power and lighting loads. Induction motor inrush currents may cause line-voltage drops that produce objectionable flickering of incandescent lights. Frequently, the taps on auto-transformers or adjustment on resistor starters can be used to reduce inrush current and minimize flickering of lights when motors are started. Lamp flicker when industrial motors are started is no different from that occurring when certain household devices are connected to lighting circuits.

There are distribution systems that will not stand induction motor starting inrushes. Any reduced-voltage starter will take care of those cases. Squirrel-cage motors are designed to have starting currents within generally accepted limits. Fig. 6 gives the starting-current curves of four types of these motors.

8. Low Starting Torque to Protect the Motor and Driven Machinery—Earlier types of induction motors could not be repeatedly started on full voltage because chafing of the stator winding end turns would eventually destroy the insulation. Most modern motors have the end windings braced to withstand full-voltage starting. It is felt by motor and control engineers that many of the objections raised to full-voltage starting are based on precedents set by earlier methods of starting. Many loads can be started on full voltage, using one of the normal-starting-torque motors available. Employment of reduced-voltage controllers in such cases is a needless investment for a more complicated device.

9. Heavy Starting Torque—The relatively low starting torque of standard squirrel-cage motors is a serious limitation to their general application. Fig. 3 shows the relative starting-torque values obtained from standard motors and from special high-starting-torque motors. None of these motors gives suitable values of torque for such applications as the average crane or traction load. A wound-rotor motor is applicable to loads requiring heavy starting torque. By properly proportioning its secondary resistance wide variations in starting torque can be obtained. Maximum starting torque is equal to the load torque that will cause the motor to stall.

Selecting Control for Wound-Rotor Induction Motors

When selecting wound-rotor induction-motor control, where heavy starting torque and consequently heavy starting current are encountered, frequency of operation will largely determine if manual control can be used. Magnetic controllers operated from master switches to give different speed points and values of starting current are in successful operation in many installations. The large number of alternating-current-motored mine hoists in use indicates that hoisting service may successfully be met by magnetic control. Steel mill main-roll drives is another type of installation where high starting torque is essential. Here, in addition to the usual master switch for speed regulating and reversing, the operator has available a maximum-torque push-button station. When the button is depressed correct resistance value to obtain the maximum torque of the motor is automatically placed in the secondary circuit.

No mention has been made of single-phase motors, which require special starting arrangements, nor of any of the commutator types of alternating-current polyphase motors. With the latter an infinite number of torque and speed values can be obtained by adjusting the position of the brushes. When the motors are combined with correct control and a mechanism for shifting the brushes a number of desirable but heretofore unobtainable operating conditions are possible.

Tests *on Two-Cycle Diesels*

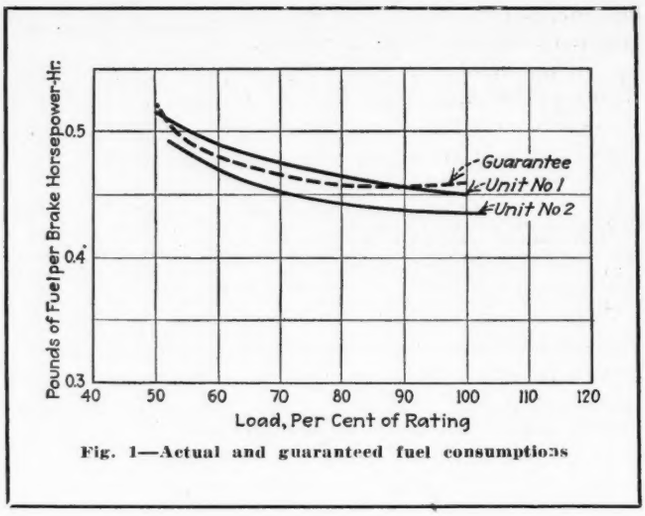


Fig. 1—Actual and guaranteed fuel consumptions

Give Remarkable Results

By EDGAR J. KATES
Consulting Engineer, New York City

THE TESTS covered in this article are notable because they were conducted by the engine *user* under load conditions that were ideal. The object was to check the guaranteed performane of a new power plant consisting of two Model 32, 360-hp. 257-r.p.m., Fairbanks-Morse Diesel engines, direct-connected to 300-kva. Fairbanks-Morse 240-volt, 2-phase, 60-cycle, 80 per cent power-factor alternators, with direct-connected exciters, erected at the factory of Sigmund Ullman Company, New York City.

While accurate Diesel engine tests are generally run on manufacturers' test blocks, comparatively few tests are made after the machines have been installed in their permanent locations, and of such tests only a small proportion are conducted in a precise manner.

To make an accurate test one must have accurate and constant loading on the engine. Such a load is seldom to be obtained in an ordinary power plant. If the engine drives a generator and is connected to the factory power

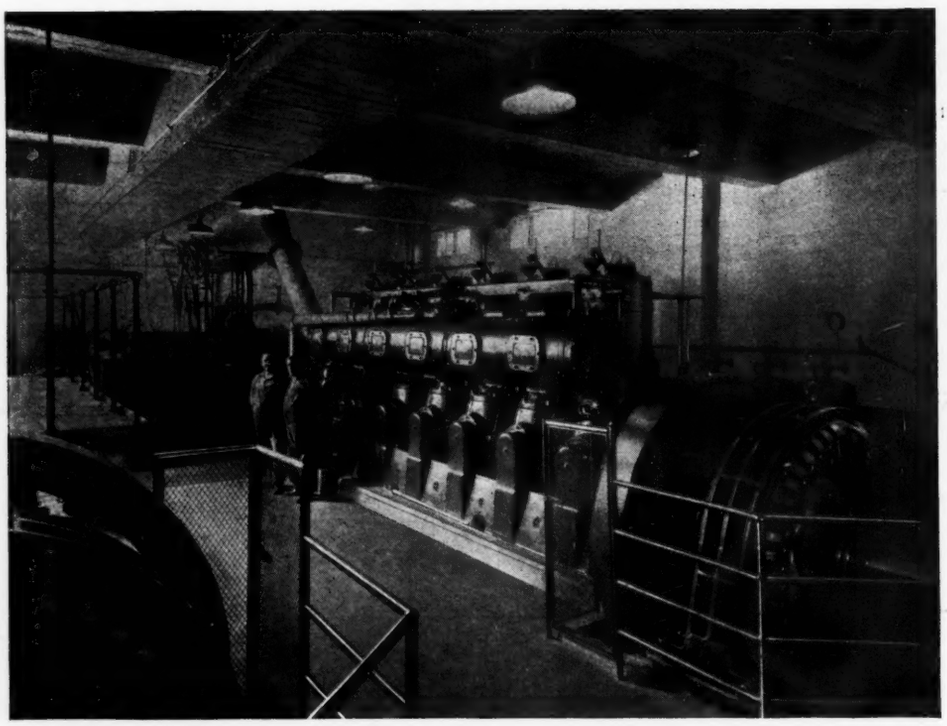


Fig. 2—View of one of the engines tested

line unavoidable load variations prevent testing the engine performance and fuel consumption at any uniform rate of power output. This makes it impossible to check engine performance against contract guarantees.

Sometimes a Diesel generating unit is loaded for acceptance-test purposes by means of a water rheostat, consisting of electrodes submerged in salt water contained in barrels or tanks. Though this gives a steadier load than the ordinary factory circuit, it is far from constant, as the changes in temperature and salinity of the water cause the resistance to fluctuate, which, in turn, produces large variations in potential and current.

In the tests I recently conducted these difficulties were completely overcome by using Nichrome resistance wire for the load. The coils of resistance wire were placed in wooden tanks and submerged in running water; the water carried off the heat, but had no part in the electrical circuit. Nichrome wire has a very low temperature coefficient, its resistance changing little with variations of temperature; consequently the resistance of these rheostats remained constant throughout all of the tests.

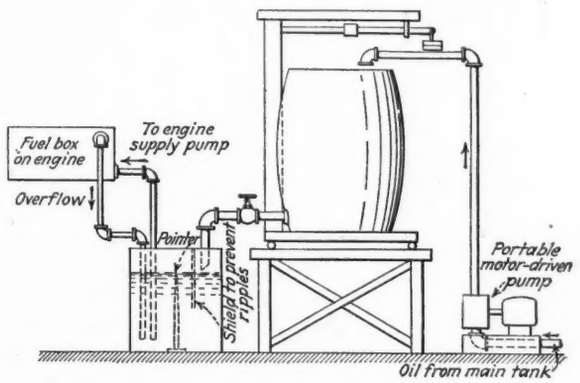


Fig. 3—Apparatus used to measure the oil

Water rheostats using salt water as an electrolyte give out noxious gases, such as chlorine and hydrogen, and are therefore not at all adapted to use indoors. Wire rheostats, however, were entirely free of electrolytic action, and as the cooling water was supplied in sufficient quantity to keep the outlet temperature low, there was no perceptible evolution of vapor, and the outfit did its work steadily and satisfactorily.

The method of adjusting the load with wire-wound rheostats is worthy of note. The electrical system is shown in Fig. 4, from which it will be seen that each coil is provided with twelve taps, each tap leading to the center of a double-throw switch. By throwing these switches into various combinations, the resistance wire can be arranged in various parallel circuits of almost any desired value. As the tests were run on two-phase generating units, two similar resistance boxes were provided, one for each phase. Placing the switches in the same relative positions on the two boxes resulted in an exactly equal loading of the phases.

All electrical instruments were calibrated, in place, before tests, by the switchboard manufacturer.

Power output is one important factor in a fuel-consumption test; the quantity of fuel consumed is the other. Fuel was measured by the simple apparatus shown in Fig. 3, which was easily fitted into the standard piping already installed on the engines. A barrel used to measure the fuel by weight fed the oil to a small tank from which the engine drew its supply by means of its regular fuel pump. The small tank was provided with a sharp pointer, and the oil level was brought exactly to this point at the beginning and end of each test run.

Full-load tests were run for a period of eight hours

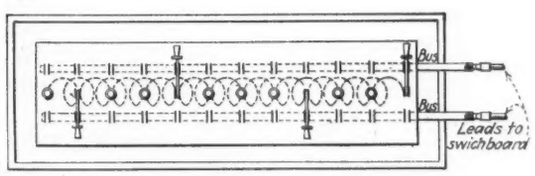
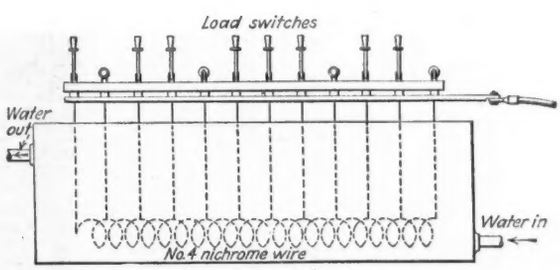


Fig. 4—The rheostat used for loading



on each engine. Three-quarter and half-load tests were run for periods of two hours each on each engine.

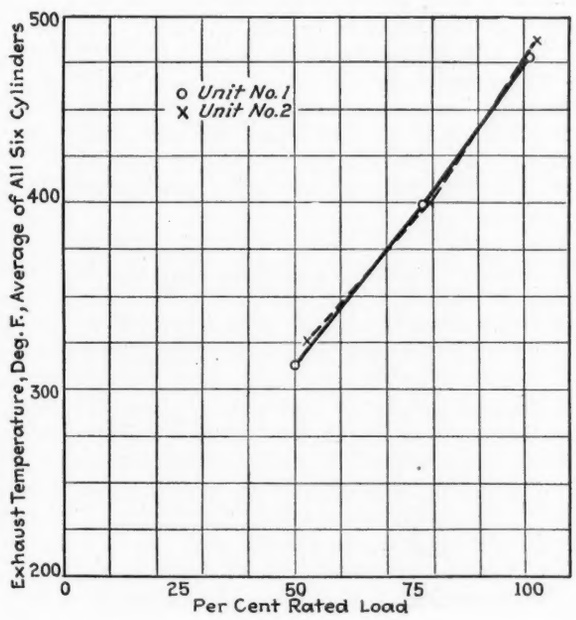
The output, measured by the watt-hour meter, was checked each hour during the full-load test, as was also the weight of fuel consumed. During the two-hour runs at partial loads output and fuel consumption were checked each half hour. Fuel oil used in these tests was supplied under the following specifications:

Gravity, deg. Baumé	28 to 32
Flash point, deg. F	170
Fire point, deg. F	190
Viscosity, at 100 deg. Saybolt sec	42 to 45
Sulphur, sediment and moisture, per cent	0.3
Cold test, deg. F	—20
Heat value, B.t.u. per gal	141,000

The gravity was checked by a hydrometer during the test and was found to be 33 deg. Baumé.

The engines were lubricated with Vacuum Oil Company's "D.T.E. heavy medium." On account of their

Fig. 5—Variation of exhaust temperature with the load



FUEL CONSUMPTION OF ENGINES

Full Load Tests

Hour After Test Began	1	2	3	4	5	6	7	8 Average for 8 Hr.
Unit No. 1								
Brake horsepower	365	362	365	360	366	366	371	367	365
Fuel per b.-hp.-hr., lb.	0.435	0.449	0.446	0.453	0.449	0.454	0.451	0.450	0.451
Unit No. 2								
Brake horsepower	369	369	372	371	369	371	371	372	371
Fuel per b.-hp.-hr., lb.	0.434	0.432	0.429	0.429	0.434	0.435	0.438	0.436	0.433

Three-Quarter-Load Tests

Half-Hour Period After Test Started	1	2	3	4	Average
Unit No. 1					
Brake horsepower	276	278	288	279	280
Fuel per b.-hp.-hr., lb.	0.470	0.468	0.453	0.467	0.465
Unit No. 2					
Brake horsepower	280	288	284	284	284
Fuel per b.-hr.-hr., lb.	0.451	0.437	0.445	0.443	0.444

Half-Load Tests

Half-Hour Period After Test Started	1	2	3	4	Average
Unit No. 1					
Brake horsepower	189	180	177	177	180.5
Fuel per b.-hp.-hr., lb.	0.494	0.516	0.525	0.525	.516
Unit No. 2					
Brake horsepower	186	196	182	192	189
Fuel per b.-hp.-hr., lb.	0.497	0.475	0.506	0.492	0.492

newness the engines' lubricating feeds were deliberately adjusted to give an oversupply, which naturally resulted in the lubricating-oil consumption being somewhat higher than normal. The clean-oil storage tank, of 25-gal. capacity, with gage glass installed for each engine, was used to measure the lubricating-oil consumption by noting the drop in level for periods of five to seven hours.

It is worthy of note that, as shown in the table, the average fuel consumption of Unit No. 2 during the eight-hour full-load test was 0.433 lb. per brake-horsepower hour, which is excellent for a two-stroke-cycle, crankcase-compression engine. A graph of the fuel consumption at various loads, as compared to the guarantees, appears in Fig. 1.

The lubrication efficiency, expressed as rated horsepower-hours per gallon of lubricating oil, was found to be 1,250 for No. 1 and 1,670 for No. 2 unit.

Exhaust temperatures were recorded throughout the tests, as such data will be useful for future reference when the engines are operating on irregular loads. When an engine is free from mechanical derangements there is a definite relation between load and exhaust temperature, as is clearly shown by Fig. 5. Temperatures are practically identical for the two engines at all loads.

Variations in exhaust temperature that were found in the six cylinders of one engine are shown in Fig. 6. The relation between individual cylinder temperatures remained almost the same as long as the load remained unchanged. Maximum range at full load was 28 deg. F., but when the load was reduced the temperature differences among the cylinders increased to 40 deg. F. at three-quarter load, and to 88 deg. F. at full load. The larger temperature variations at light loads are probably caused by slight differences in angular positions of the several governor-cam rocker arms. However, if adjustments are made to give equal cylinder loading at full load, the variations at lighter loads are unimportant, as there is no possibility of any cylinder being overloaded at such times.

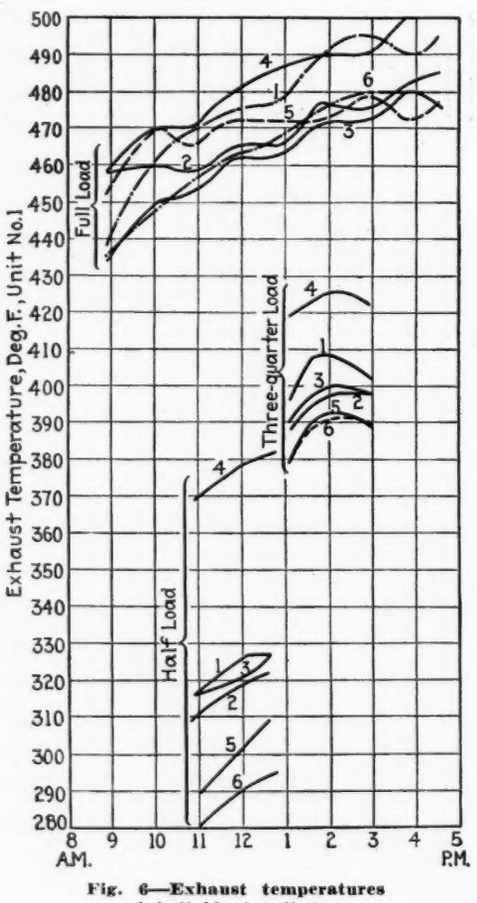


Fig. 6—Exhaust temperatures of individual cylinders

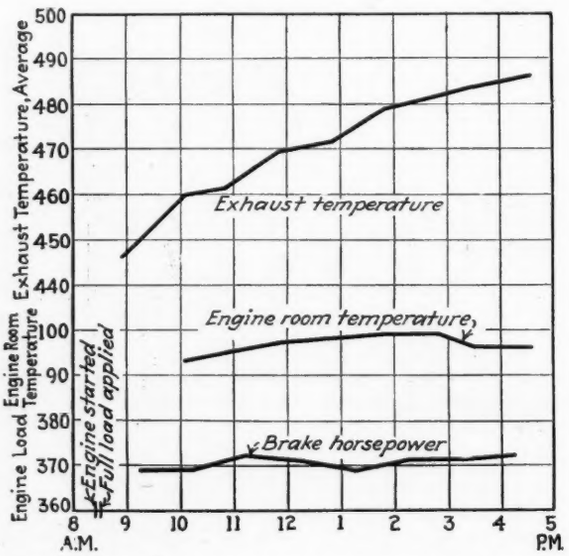


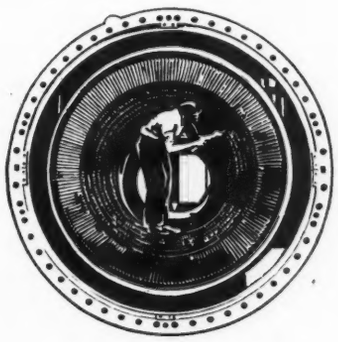
Fig. 7—Variation of exhaust temperature with time

The manner in which the exhaust temperature gradually increased during the eight-hour full-load test is shown in Fig. 7, which covers the average of all six cylinders. The temperature rose from 446 deg. F. half an hour after the load was applied, and to 486 deg. F. 7½ hr. later. The corresponding curves of engine room temperature and brake-horsepower show that the exhaust temperature increase cannot be attributed to variations in these factors. Probably the increase was due to the slow warming of the heavy engine base, which in turn warmed the scavenging air during its passage through the engine.

The notable feature of these tests is the excellent fuel consumption.

What Is the Ultimate?..

TEMPERATURE • PRESSURE • REHEAT



By KARL A. MAYR
Engineer, New York Office, Siemens Schuckertwerke, A.G.

IN THE race to obtain more power from a pound of coal or, more properly, more power per dollar of total cost, two opposing trends have been noticed of late.

"Increase the steam pressure" we hear from one camp and we see a boiler generating steam at 3,200 lb. per square inch. "Use higher steam temperatures" is the cry of the other camp, and a superheater is built to heat steam of normal pressure up to 1,000 deg. for use in a man-size turbine.

The low-pressure end of the power plant has been called upon more and more to improve over-all plant economy by installing multi-stage feed-water heaters using bled steam. This is today a generally accepted expedient. The use of resuperheaters is promoted by the engineers who favor higher steam pressures, whereas those who favor higher temperatures tend to call this apparatus an unnecessary complication.

Some use steam as the reheating medium, while others do the reheating by means of hot gases from burnt fuel. Still others prefer a combination of steam-and-gas-heated reheaters.

From the purely thermodynamic viewpoint, there must be an optimum process for the generation, utilization and interstage regeneration of steam which shows best results, i.e.—which produces the most power from a given amount of fuel. Consideration of costs and other practical matters may, of course, alter the situation completely.

To determine the influence of initial steam pressure and temperature, of various efficiencies of the high pressure turbine, of reheating in one or two stages (and by means of live steam or gas) and of feed-water heating, I have studied twenty different processes. The computed results are shown in the accompanying diagram and Table I.

Some of these processes are based on initial steam pressures and temperatures as we find them in existing power plants and their course down to condensation is designed to conform with good turbine practice.

All processes are based on a steam flow of 100,000 lb. per hour to the high-pressure turbine. Although the production of this amount of steam requires different amounts of fuel, depending on the steam pressure and temperature and heat content of the feed water, it gives an idea as to how much power can be obtained from this steam at the various initial steam conditions.

In all cycles using an initial steam pressure of more than 2,000 lb. per square inch. the power consumption of the feed pump has been assumed as large enough to pump the water againt a pressure of 3,400 lb. This assumption is made because the reliable generation of steam at such high pressures undoubtedly requires special means to secure a definite and much faster circulation of steam and water through the heating tubes than is the case in an ordinary natural-circulation boiler.

The figure of 3,400 lb. would, of course, apply to the Benson steam generator. It is believed, however, that the use of other types of steam generators, such as the "steam pumping" Loeffler generator, would lead to similar power requirements. The excess pressure to which the water must be pumped is not so high, but to secure the amount of heat necessary for evaporating the water, and to obtain the desired circulation velocities, a multiple of the amount of steam which is withdrawn from the system for power-generating purposes must be circulated through the heating tubes.

Similar conditions will be found in other systems working with forced circulation, such as, for example, the Lamont system. Provision for excess power consumption should, in the writer's opinion, have been made in all processes using higher steam pressures than 1,200 lb., as it is his belief that such steam cannot be continuously safely and practically generated without special circulation arrangements. However, in order not to favor the higher steam pressures too much, this assumption has been confined to presures about 2,000 pounds.

Power necessary for driving auxiliaries other than the feed pump, such as air and draft fans, circulating pumps, condensate pumps, etc., was assumed to be mainly in proportion to the amount of steam to be condensed.

The various cycles and the initial steam temperatures have been chosen so that steam enters the reheaters either

TABLE I—SUMMARY OF CALCULATIONS OF PERFORMANCE FOR VARIOUS ASSUMED CONDITIONS

Initial steam pressure, lb. abs.	3,000						2,500						2,250		1,800		1,200		1,000	
Initial steam temp., deg. F.	830				975		840						1,000		840		840		1,000	
Number of reheat stages	2 live-steam		2 gas-heated		1 gas-heated		1 gas-heated						1 gas-heated		1 gas-heated		1 gas-heated			
Number of feed-water heating stages	4	3	4	3	4	3	4			3			4	3	4	3	4	3	4	3
Pressure (lb. abs.) of reheated steam after 1st stage	550				95		240						70		95		70			
Pressure (lb. abs.) of reheated steam after 2nd stage	130																			
Temperature (deg. F.) of reheated steam after 1st stage	600				550		750						500		550		500			
Temperature (deg. F.) of reheated steam after 2nd stage	600																			
Pressure range of h.p. turbine stages of equal efficiency, lb. absolute	3,000–570				3,000–1,800 1,800– 500		2,500–570						2,250–1,200 1,200–270		1,800–500		1,200–270		1,000–270	
Efficiency of these stages, per cent	70				65 70		40	55	70	40	55	70	65 70		70		70		70	
Pressure range of h.p. turbine stages of equal efficiency, lb. abs.	550–150				300–100		570–270						270–75		500–100		270–75		270–100	
Efficiency within these stages, per cent	75				75		75						75		75		75		75	
Pressure range of l.p. turbine stages of equal efficiency, lb. abs.	130–0.71				93–0.71		242–0.71						75–0.71		93.0.71		70–0.71		100–0.71	
Efficiency within these stages, per cent	80				80		80						80		80		80		80	
Feed-water temp., deg. F.	445	350	450	325	380	310	450	450	450	380	380	380	380	310	380	310	380	310	380	310
Amount of steam to be condensed, lb. per hr.	70,600	80,800	70,600	80,800	75,600	82,000	72,100	70,300	70,000	77,500	79,000	76,500	75,000	80,300	75,600	82,000	75,000	80,300	77,100	82,200
Output of h.p. turbine, kw.	3,230	3,230	3,230	3,230	1,340 5,940	1,340 6,000	1,760	2,470	3,080	3,320	3,850	4,460	1,675 3,350	1,675 5,400	5,940	6,000	3,350	5,400	3,350	3,350
Output of m.p. turbine, kw.	2,520	2,930	2,520	2,930	3,197	3,428	1,435	1,270	1,265				2,523	680	3,197	3,428	2,523	680	2,190	2,340
Output of l.p. turbine, kw.	6,380	7,360	6,380	7,360	3,100	3,370	8,000	7,990	7,850	8,690	8,610	8,592	5,460	5,870	3,100	3,370	5,460	5,870	6,214	6,632
Total turbine output, kw.	12,130	13,520	12,130	13,520	13,577	14,138	11,195	11,730	12,195	12,010	12,460	13,052	13,008	13,625	12,237	12,798	11,333	11,950	11,754	12,322
Power consumption of boiler-feed pumps, kw. over-all effic. of pump 60 per cent.	590	640	463	463	463	463	463						460		290	300	187	190	187	
Power consumption of other auxiliaries, kw.	226	270	226	270	254	275	242	238	235	260	258	256	250	269	254	275	250	269	258	276
Outgoing power, kw.	11,314	12,810	11,941	12,787	13,160	13,400	10,490	11,029	11,497	11,287	11,739	12,333	12,295	12,893	11,693	12,223	10,896	11,491	11,309	11,859
Over-all heat rate of plant, B.t.u./kw. (boiler and reheater effic. 90 per cent; steam reheater, 96 per cent)	10,620	10,750	10,420	10,700	10,500	11,000	10,880	10,420	10,100	10,900	10,500	10,130	10,110	10,900	10,950	11,180	11,520	11,620	11,350	11,460
Unaccounted losses, 5 per cent	532	538	521	535	528	550	543	521	505	545	525	507	536	545	547	558	576	581	568	573
B.t.u. per outgoing kw	11,152	11,288	10,941	11,235	11,088	11,550	11,423	10,941	10,605	11,445	11,025	10,637	11,296	11,445	11,497	11,738	12,096	12,201	11,918	12,033
Coal per outgoing kw. (heat value 14,000 B.t.u. lb.)	0.797	0.806	0.783	0.804	0.791	0.825	0.818	0.782	0.76	0.819	0.79	0.701	0.804	0.819	0.82	0.84	0.863	0.874	0.85	0.86
Over-all plant efficiency, per cent	32.1	31.7	32.7	31.9	32.3	31	31.35	32.7	33.8	31.3	32.5	33.6	31.8	31.3	31.1	30.55	29.6	29.3	30	29.8
Cycle No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

dry saturated or with very little superheat. The final exhaust conditions are in all cases the same, namely, 2 in. vacuum and 6 to 8 per cent moisture.

Method of Computing Table I

In working up the figures for the individual cycles the following method was used:

The condensate flowing back to the boiler is equal to the total of the steam going into the condenser and the various feed-water heaters and is in all cases 100,000 lb. per hour.

$$S_1 + S_2 + S_3 + X = 100{,}000 \text{ lb. per hour.}$$

where S_1, S_2, S_3, etc. = Steam per hour to heaters 1, 2, 3, etc.,

and X = Steam to condenser.

The increase of heat content of water passing a feed-water heater is equal to the decrease of heat content of heating steam flowing through this heater. For example, in the case of heater 3,

$$W_3\ q_3 - W_2\ q_2 = S_3\ (H_3 - q'_3)$$

W_3 = Water per hour emerging from heater 3.

W_2 = Water per hour emerging from Heater 2.

q_3 = Heat content of 1 lb. of water emerging from Heater 3.

q_2 = Heat content of 1 lb. of water emerging from Heater 2.

H_3 = Total heat of steam bled into heater 3.

q'_3 = Heat content of condensate of S_3 flowing from Heater 3 into Heater 2.

For Heater 2 we would have,

$$S_2\ (H_2 - q'_2) = W_2\ q_2 - S_3\ q'_3\ (W_2 - S_3)\ q$$

Heater 1 (open heater)

$$S_1\ H_1 = (W_2 - S_3)\ q_1 - S_2 \times q'_2 - X\ q$$

q = Heat content of 1 lb. condensate from condenser.

The temperature of condensate of the heating steam was generally assumed to be 20 deg. in excess of the temperature of the water entering the heater. Similarly, temperature of water leaving the heater was assumed to be 20 to 30 deg. below the saturation temperature of the heating steam.

In this way the amount of bleeder steam, and, finally, the amount of steam going to the condenser, was calculated.

Temperature of the condensate leaving the condenser is in all cases 100 degrees.

Bleeder connections were assumed wherever the steam enters a steam reheater and on convenient intermediate points on the turbines.

To study the effect of higher feed temperatures some of the columns of Table I have been recomputed on this basis. The corresponding figures are shown in Table II.

The following bleeder pressures are used for the indicated cycles:

Cycles	Lb., Abs.			
1 and 3	15	70	125	570
2 and 4	15	70	125	...
5 and 15	15	70	100	270
6 and 16	15	70	100	...
7–9	15	70	270	570
10–12	15	70	270	...
13, 17, 19	15	75	100	270
13a and 17a	15	75	270	570
14a and 18a	15	75	270	...
14, 18, 20	15	75	100	...
5a and 15a	15	100	270	570
6a and 16a	15	100	270	...

Feed-water heating in three and four stages has been figured. It is possible to carry the temperature of the feed water too high by means of bled steam. An important factor in this connection is the thermal efficiency of the high-pressure turbine. For a given steam flow the efficiency of the high-pressure stages will always be smaller than that of the low-pressure stages. Higher feed-water temperature is obtained by reducing the steam flowing to the more efficient low-pressure stages. Thus, in installations having high-pressure turbine parts of small efficiency, the addition of another heating stage may often add very little to the over-all plant efficiency (See process 7 and 10. Also 5 and 5a, 6 and 6a.)

In many cases a slightly increased initial steam pressure, which involves no additional complicated apparatus, would yield the same increase in over-all economy as the possibly much more expensive provision of another feed-water heating stage.

One cycle using two reheat stages was investigated, considering steam-heated reheaters and reheaters in the gas flow. The use of steam at 3,000 lb. or higher pressure as heating medium is attractive in many ways. The

TABLE II, SUPPLEMENT TO TABLE I, SHOWING EFFECT OF HIGHER FEED TEMPERATURES

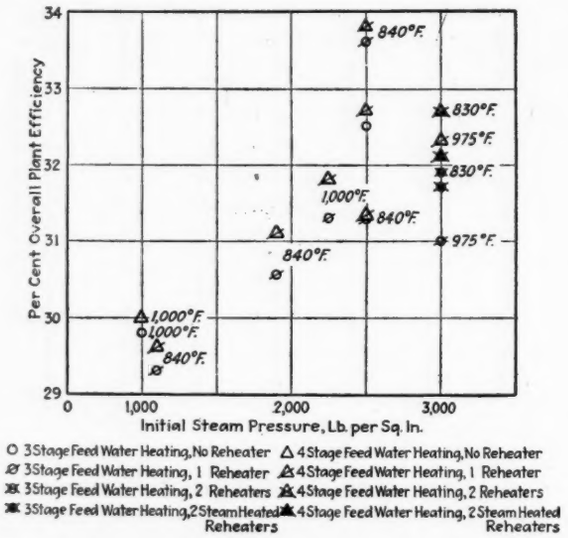
[Note—The columns are numbered at the bottom to correspond with the columns in Table I. Thus 5a follows 5, 6a follows 6, etc.]

Feed of water, temp., deg. F	450	380	450	380	450	380	450	380
Amount of steam to be condensed, lb. per hr	69,300	75,300	69,400	75,200	69,300	75,300	69,400	75,200
Output of h.p. turbine, kw	1,340		1,675	1,675	4,023	5,940	3,230	3,350
	4,023	5,940	3,230	3,350				
Output of m.p. turbine, kw	1,585	2,360	2,310	1,900	1,585	2,360	2,310	1,900
Output of l.p. turbine, kw	5,660	3,100	5,085	5,490	5,660	3,100	5,085	5,490
Total turbine output, kw	12,608	12,740	12,300	12,415	11,268	11,400	10,625	10,740
Power consumption of boiler-feed pumps, kw. (over-all efficiency of pump, 60 per cent)	463		463		290	300	187	190
Power consumption of other auxiliaries, kw	233	253	230	250	233	253	230	250
Outgoing power, kw	12,012	11,994	11,607	11,702	10,745	10,847	10,208	10,300
Over-all heat rate of plant, B.t.u.; (boiler and reheater effic. 90 per cent; steam reheater, 96 per cent)	10,750	11,500	10,100	10,560	10,450	11,650	11,020	12,180
Unaccounted losses, 5 per cent	515	530	505	511.5	522	582.5	551	609
B.t.u. per outgoing kw	11,265	12,030	10,605	11,071	10,972	12,232	11,571	12,789
Coal per outgoing kw (heat value 14,000 B.t.u. lb.)	0.804	0.86	0.758	0.79	0.783	0.875	0.826	0.913
Over-all plant efficiency, per cent	31.7	29.7	33.7	32.3	32.6	29.3	30.9	28
Cycle No.	5a	6a	13a	14a	15a	16a	17a	18a

method requires very small heating surface, which could be arranged integral with the turbine casing, and little in the way of control complications, the amount of heating steam being always in proportion to the amount of steam passing through the turbine. However, the additional power requirements of the feed pump for handling the water for this heating system puts this process, as far as over-all economy is concerned, into a lower range. (Process 1-4).

The efficiencies for the same pressure, however, are higher using two-stage reheating than when using one-stage and increasing the initial steam temperature to a point not higher than needed for dry-saturated steam at the turbine exhaust. (Process 5, 6.)

Raising the steam temperature to 1,000 deg. and eliminating the reheater altogether leads to a pressure of 1,000 lb. if normal turbine efficienices and the same condenser condition as in all the other processes are assumed. Although this type of installation is very simple, provided the maintenance of such a steam temperature does not involve too many difficulties, its over-all efficiency is considerably lower than that of plants work-



Graphical summary of the efficiencies listed in Table 1

ing with reheaters and higher steam pressures instead of higher temperature. (Process 19 and 20.)

The outcome of this investigation, which covers an extensive range of cycle possibilities, follows:

Considering possible cycles in condensing turbine power plants using steam of not more than 3,000-lb. pressure and 1,000 deg. F. the greatest over-all efficiency can be obtained with an initial pressure of 2,500 lb. and an initial temperature of 840 deg., reheating this steam at 240 lb. to 750 deg. F. Using still higher pressure and multi-stage reheating has no improving influence.

The pressure at which the steam is reheated should be low and only saturated or slightly superheated steam should enter the reheater.

Heating feed water by bled steam has a beneficial effect on the over-all efficiency; however, the same result might in many cases be obtained by increasing the steam pressure. The ultimate temperature to which the feed water should be heated is to a great extent determined by the efficiency of the high-pressure turbine stages.

Use of high superheats to avoid reheaters involves temperatures much above 1,000 deg. F., if the plant is to compete with the reheating high-pressure plant.

Year's Construction Projects Summarized by N.E.L.A.

WHILE reported in detail in the news pages of *Power* from time to time, the following construction projects are of particular interest as recently summarized by the National Electric Light Association. According to this summary the eleven largest construction projects of electric light and power plants to be completed or work upon which is to be begun this year will have an ultimate producing capacity of nearly three million horsepower and will require the investment of more than $500,000,000. In addition, there are numerous smaller projects, which will involve the outlay of other hundreds of millions of dollars. Of the eleven large projects, five are steam and six are hydro.

One of these projects has just been completed and placed in commission. It is a 150,000-hp. steam generating station built by the Duke Power Company of Charlotte, N. C., at River Bend, N. C. This is one of the largest steam plants in the Southern States and has a 50 per cent greater capacity than any of the numerous generating plants owned or operated by the Duke Power Company.

ON THE SALUDA RIVER, in South Carolina, the Lexington Water Power Company is installing, as an initial development, four units of 50,000 hp. each, the plant to have an ultimate capacity of 260,000 horsepower.

The proposed development of the Knoxville Power Company at Calderwood, N. C., includes seven dams in North Carolina and one in Tennessee, all in the vicinity of Bryson City, N. C., and will have an ultimate capacity of 168,000 horsepower.

IN NEW JERSEY two definite projects have been decided upon—one by the Eastern New Jersey Power Company, which will be a steam plant at Sayreville with an eventual capacity of 240,000 hp., and the other by the Jersey Central Light Company, which will install two compound steam turbine-generators at South Amboy, the plant to have an ultimate capacity of 360,000 horsepower.

At Pittsburgh, Pa., the Duquesne Light Company will construct, during the next ten years, the James A. Reed plant, which will have a final rating of 400,000 hp., with an initial unit of 80,000 horsepower.

The Buffalo General Electric Company has announced plans for erection of an additional 107,000-hp. unit at its Charles R. Huntley steam plant, which will bring its capacity up to more than 600,000 horsepower.

IN NEW ENGLAND the New England Power Association (Grafton Power Company) is constructing a great hydro-electric development at Fifteen Mile Falls with an initial installation of 160,000 hp. and a later installation of 140,000 horsepower.

The Empire District Electric Company will install four 28,000-hp. generators at Table Rock, Mo., with a dam 197 ft. high and a final generating capacity of approximately 100,000 horsepower.

On the Pacific Coast the city of Seattle will add the Diablo Dam to its Skagit project, 120,000 hp. in generating capacity. The Southern California Edison Company will add to its Long Beach No. 3 plant a further installation of 133,000 hp. Total capacity of Long Beach, when completed will be well in excess of a million horsepower.

European Low-Head Hydro-Electric Developments

BY A. V. KARPOV
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This article is part of a report made by the author after an extended trip through Europe. Two low-head projects are described: The Ryborg-Schworstadt and the Kembs, both located on the River Rhine. The former is designed for four 35,000-hp. Kaplan turbines to operate under a 35-ft. head, and the latter includes five 36,000-hp. propeller turbines for a 54-ft. head. In the Kembs project the spillway is built into the plant, but at Ryborg-Schworstadt the spillway is in the dam adjoining the plant and is controlled by four gates, 39 ft. high by 80 ft. wide.

PROBABLY the most interesting of present-day European water-power undertakings are those for heads of 80 ft. and less. The introduction of and the rapid increase in size of propeller and Kaplan turbines have changed the economical aspects of these projects and made possible developments that a few years ago were considered impracticable.

The upper part of the Rhine River, between Lake Constance and Strasbourg, gives an interesting picture of low-head possibilities. Two large plants are under construction: Ryborg-Schworstadt, on the border line between Germany and Switzerland, near Rhinfelden, and Kembs, on the French side of the Rhine, near Mulhouse. In both of these plants the waterwheels have the largest physical dimensions and pass more water than any units yet built. A comparison of some of the chief features of these two plants is given in the table.

The economical advantage of using large Kaplan turbines for low heads can be seen by comparing the Laufenburg and Ryborg-Schworstadt plants. These stations are similar in head and capacity and are located a short distance apart. The Laufenburg plant was built before the war with a large number of Francis turbines. Taking into consideration the differences in the pre-war and present-day prices, the cost of an installed kilowatt in Ryborg-Schworstadt is estimated to be 30 per cent lower than in Laufenburg.

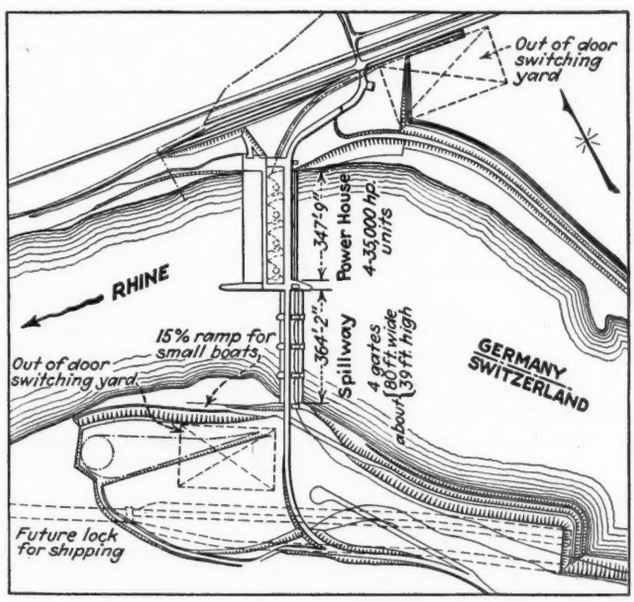


Fig. 1—The Ryborg-Schworstadt plant is located in a dam across the Rhine River

The Ryborg-Schworstadt plant is located in a dam built across the Rhine, Fig. 1, a cross-section through one of the Kaplan turbines being shown on Fig. 2. Water enters the concrete scroll case through three passages between concrete piers, and passes through guide vanes and wicket gates into the runner. After leaving the runner, water enters the draft tube, which has a steadying partition and a supporting pier, indicated in Fig. 2. The structural design of the power house is based on the piers in the intake and draft tube, which are used to carry the power house load. The thrust bearing load is carried down in solid masonry, partly by the guide vanes of the turbine.

An unusual feature of this design is the absence of headgates. Normally the turbine is stopped by closing the wicket gates and applying brakes to bring the runner to a stop in case of leakage through the gates. If the wicket gates become inoperative the unit may be stopped by turning the runner blades to the neutral position and

COMPARATIVE DATA OF THE RYBORG-SCHWORSTADT AND KEMBS PLANTS

	Ryborg-Schworstadt	Kembs
Head, feet	35	54
Type of turbines	Kaplan	Propeller
Number of units	4	5
Capacity of each, horsepower	35,000	36,000
Total capacity, horsepower	140,000	180 000
Rated full-load water for each unit, sec.-ft.	10,500	6,800
Speed, r.p.m.	75	94
Runner diameter, ft.	23.0	18.4

applying the brakes. For emergency repair work, stop log provisions are made.

Another interesting feature of this plant are the main gates in the dam. From the maximum total flow of the Rhine River, that can be as high as 200,000 sec.-ft., about 35,000 can be discharged through the power house. The rest must be taken care of by four gates. These have a clear opening of about 80 ft. wide x 39 high and are of Maschienenfabrik Augsburg Nurnberg design.

A section through one of the gates and a plan view are shown in Fig. 3. Each gate consists of an upper and a lower part. The lower part is stiff enough to carry the water pressure, but the upper part has a stiffening beam at the top only, the bottom being flexible so that water can press it against the stiff lower part. A rubber strap fixed to the lower part of the gate and sliding against the upper part insures a water-tight joint. Water tightness at the bottom is assured by a wooden beam pressing against a steel-plate sill. At the sides of the gates, tightness is obtained by flexible steel plates that are pressed against structural steel guides.

An electrically operated overhead crane raises or lowers the gates. Either the upper part of the gates may be lowered or the lower part may be raised, and the final operation is to lift the whole gate out of the water. This arrangement gives good water control. Floating rubbish is passed down stream by the water flowing above the gates. Raising the gates removes sand and gravel accumulations that collect at their bottoms.

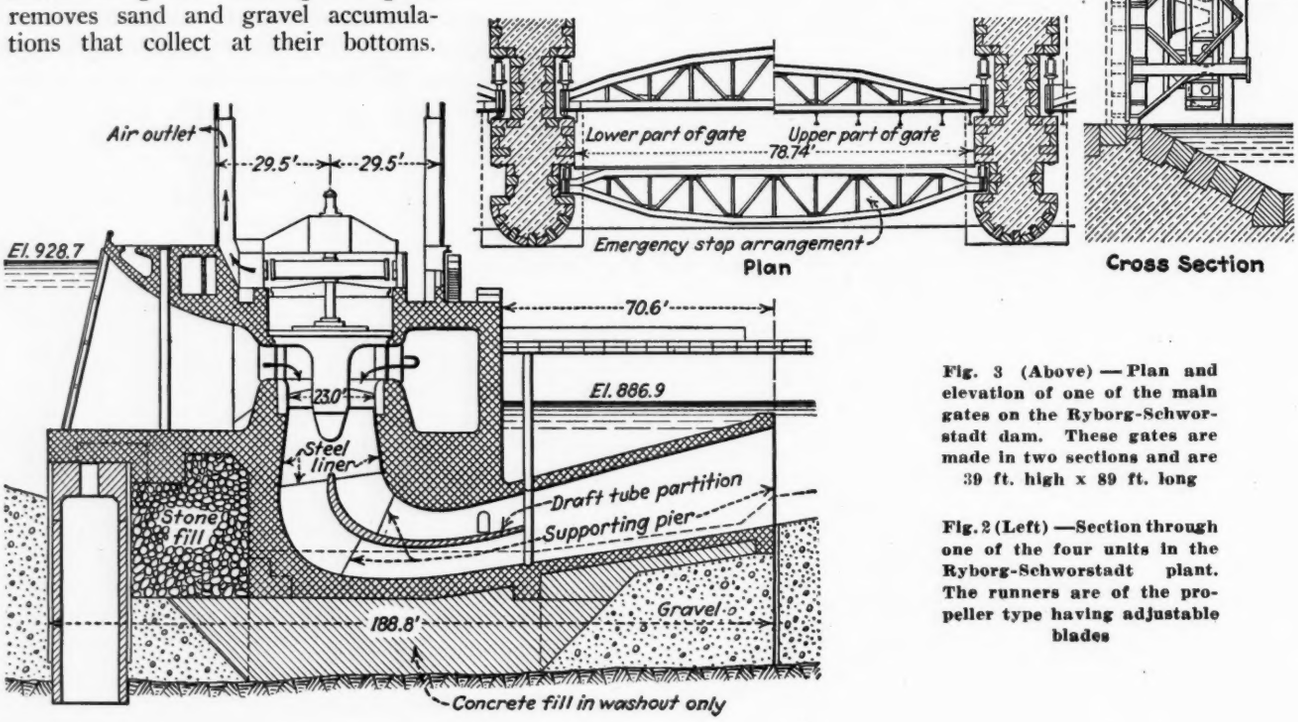


Fig. 3 (Above) — Plan and elevation of one of the main gates on the Ryborg-Schworstadt dam. These gates are made in two sections and are 39 ft. high x 89 ft. long

Fig. 2 (Left) —Section through one of the four units in the Ryborg-Schworstadt plant. The runners are of the propeller type having adjustable blades

Since the size of the opening does not permit using stop logs, a number of steel frames handled by an auxiliary crane and held in specially provided slots can be used to stop the water in an emergency or when a gate is being cleaned and repaired. These frames are covered with sheet metal and are made water tight at all points by wooden beams that are permanently connected to the steel frames. Gates of this design are becoming popular for large sizes, and plans have been made for gates larger than those at Ryborg-Schworstadt.

The Kembs plant is the largest and first of eight proposed on the shipping canal (Grand Canal d'Alsace) that is to be built between Basel and Strasbourg as part of the German reparation payments. This plant is located in the canal. The plan, Fig. 4, and the cross-section, Fig. 5, of the power house show a design quite different from Ryborg-Schworstadt.

A customary design with a dam, the necessary gates, spillway and power house would require a much wider canal at the power plant than is now necessary. The design adopted was worked out to take advantage of the main regulating gates being located in the dam on the Rhine River and the limited amount of water that flows through the canal.

For each unit in the power house there are eight intakes controlled by headgates. Four, on the lower level, lead the water to the concrete scroll case of the turbine. The four upper intakes control the water of the overflow spillway, indicated in Figs. 4 and 5 by dotted lines.

Each unit is completely separated from the spillway by the central concrete pier, as shown on section *BB*, Fig. 4. Closing the lower and opening the upper intake gates of a unit allows the water to flow at the outsides of the central pier, and inspection or repairs can be made by removing the generator's rotor, and, if necessary, the turbine runner, without interference from the overflow water. The spillway and draft-tube outlets are brought together in such a way as to increase the turbine's output during flood periods when the tail water is high.

Supporting piers in the intakes and draft tube and the draft-tube partition are similar to those in the Ryborg-Schworstadt design. Emergency stop logs are provided for in the intakes, draft tubes and spillways. Both the Ryborg-Schworstadt and Kembs developments indicate thorough and careful planning that can be obtained only by close co-operation between the turbine and power house designers supported by proper hydraulic laboratory studies.

For a low-head development there are three possible

choices of turbines: Propeller, Kaplan, and a combination of the two.

The Kembs development is an example of the first choice, and Ryborg-Schworstadt of the second. The Lilla Edet power plant in Norway with two propellers (Lawaczeck) and one Kaplan turbine represents the third choice. These units are rated at 11,200 hp. under a 21-ft. head.

Propeller turbines are simpler, cheaper and have a high efficiency at near full load, but at part load the efficiency decreases rapidly. Kaplan turbines are more complicated and expensive, but have a flat efficiency curve for a wide range of load. They will, however, generally have a slightly lower maximum efficiency than the best propeller turbines.

A good illustration of the difference between the efficiencies of a Kaplan and a propeller turbine is that for 40,000-hp. units the amount of water necessary to turn an idle propeller turbine will deliver about 10,000 hp. in a Kaplan turbine. Approaching full loads the amount of water required for about 39,000 hp. with a propeller turbine will produce less than 38,000 hp. if passed through a Kaplan turbine. These differences in the two types of turbines, combined with local conditions, will govern the proper choice.

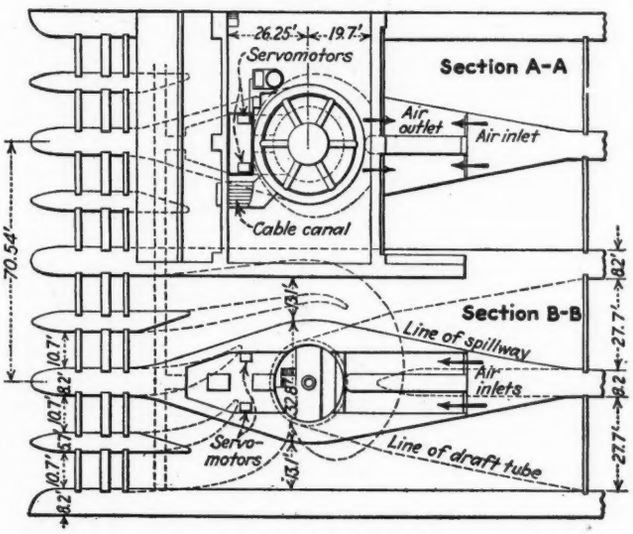


FIG. 4—PLAN OF TWO OF THE FIVE UNITS IN THE KEMBS PLANT

This plant is located in the Grand Canal d'Alsace and the spillway is built into the plant above the waterwheels

In the Kembs project, with five units and gradual changes in available water, varying the number of units in operation will allow operating most of the time at good efficiency. For this reason propeller turbines were selected.

In Ryborg-Schworstadt plant every unit is owned by a different concern, and it is expected to operate the four units continuously and change the load of each unit according to the water available. Therefore, it was thought advisable to use all Kaplan turbines. Selecting this type of turbine made it possible to eliminate the headgates, and in this way to compensate partly for the unit's higher cost.

Lilla Edet power house probably better represents average conditions. There the propeller units are operated at maximum efficiency and the Kaplan unit takes care of the load changes.

Insurance against changes of conditions assumed in the original design can be had by building the propeller turbines so that a Kaplan runner may later be installed if desirable.

Laboratory tests are particularly important in low-head developments. Francis turbines can be designed and their performance closely predicted without tests. A propeller or Kaplan turbine can be properly designed only if the preliminary design is modified according to model tests.

Not only the turbines, but also the design of the entire power plant should be checked by laboratory tests. The large quantity of water to be handled and the inability to determine without tests the influence that the proposed structures will have on the behavior of the river make laboratory studies of utmost importance. Expenses and time required for laboratory tests pay handsome dividends in more economical structures and better designs.

A good example of how low-head designs are handled and the co-operation between power plant designers, turbine manufacturers and hydraulic laboratories is shown in the design of the Ryborg-Schworstadt development. A preliminary study of the development was made and the approximate location of the proposed dam and power house determined. This information was given to the Karlsruhe Laboratory, where a complete model was built of the Rhine River section involved. An extensive series of tests was made to determine proper location of the dam and power house, conditions that would prevent erosion of the river's bed, river protection necessary above and below the dam, conditions to be met to protect shipping interests, possibilities of sand and gravel accumulation at the intake, influence of cofferdams, and other factors. At the same time the three waterwheel manufacturers chosen to deliver the Kaplan turbines, J. M. Voith, Germany; Escher Wyss & Co.; and Atelier des Charmilles, Switzerland, made preliminary designs of the turbines, built models of them, including scroll cases and draft tubes, and tested the models to determine their efficiency, cavitation limitations, runner blades' adjustments, shape and location of the dividing partitions and supporting piers, and other features.

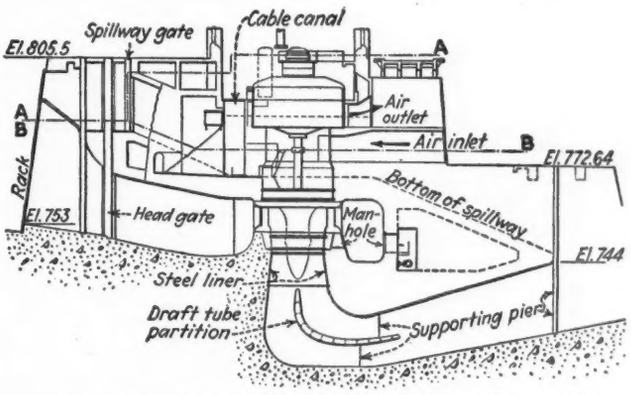


FIG. 5—CROSS-SECTION OF ONE OF THE FIVE UNITS IN THE KEMBS PLANT

These units have propeller type runners with fixed blades, are rated at 36,000 hp. and operate under a 54-ft. head

Results of tests made in Karlsruhe, as well as those made by the turbine manufacturers, were put before all parties, and the necessary modifications in the preliminary design were discussed and decided. In this way the design was modified a number of times until the best possible combination was found and the final design that is now under construction was adopted.

Notes on Air-Cooled Boiler Refractories

By Edwin Smiley

INTRODUCTION of the inclined underfeed-type of stoker in 1905 materially changed boiler furnace conditions and requirements. The rate of combustion per square foot was increased, boilers were raised higher above the fuel bed, furnace volumes were increased, and smokeless combustion was achieved. The furnace walls required greater care and engineering skill in design and construction to avoid expensive maintenance.

It became necessary to protect the grate line of stoker installations with air-cooled carborundum blocks. The best form of these were hollow, but with a solid face, allowing the return of preheated air under the grates again. It was sometimes found more convenient to admit the cooling air into the fuel bed at the grate line through perforated carborundum blocks. This practice however, lowers the CO_2 at the sides of the furnace. With low-fusion ash coal there is also the danger of slagging over the holes.

The next step forward with the increasing height of stoker setting was sectionally supported walls. The type used on such an installation as the new West Philadelphia heating plant of the Pennsylvania Railroad will usually show a higher return on the investment than water walls, with possibly the following exceptions: Lower rear walls with rotary ash-discharge stokers; sections of the grate line exposed to abrasion; when the furnace temperatures exceed the fusing point of the ash; extremely high duty installations with preheated air. Incidentally, air-cooled walls on a job of this size cost little more than a solid firebrick setting.

AS TO FUTURE developments on extended furnaces with underfeed stoker installations, the use of sectionally supported walls is to be recommended for walls overhanging the fuel bed. On the rear wall of such installations, the fire face of the tile should be protected by some form of water cooling. It may be found more convenient, on front walls, to support and insulate these sectionally rather than to use water or air cooling.

Use of comparatively thin tile walls on high boiler settings, because they are sectionally supported, is certain to cause excessive radiation losses at higher ratings. Provision should, therefore, be made for air-cooling the tile to recover this radiation loss wherever possible.

The introduction of pulverized fuel altered the service required of furnace refractories. Competition of pulverized fuel combustion with the burning of fuel on modern underfeed stokers has served to bring about a constantly increasing rate of evaporation per square foot of heating surface in the boiler, larger furnace volumes, and an ever-increasing number of problems in the design of furnace walls. Use of fuel oil and refuse wood from furniture and automobile-body manufacturing plants has also created severe conditions for furnace refractories.

An important development in pulverized coal furnace wall construction was that of the supported side wall, which may be air-cooled. This proved quite satisfactory for the operation of boilers at ratings less than 300 per cent.

With the introduction of pulverized coal and boiler ratings in excess of 300 per cent, air-cooled refractory side wall construction has not in all cases proved satisfactory. Water-cooled side walls have been introduced in which the refractory walls are protected with tubes through which water passes in connection with the circulation in the boilers. The tubes may be placed adjacent to the wall on the inside of the furnace, the entire furnace wall may be constructed of tubes with a small amount of refractory and insulating material on the outside, or the tubes may be arranged with strips of steel fin-like in form welded to the tubes to present a solid metal surface to the fire. Frequently a combination of water-cooled and air-cooled walls is used in which the water-cooled surfaces are subjected to the more severe conditions.

AIR-COOLED refractory walls may be segregated under two general classifications, namely:

1. Walls in which special refractory shapes are definitely held in position by structural steel and cast-iron members which also support the weight of the refractories.
2. Walls in which special refractory shapes for furnace lining are bonded to the main wall but are not supported thereby.

Water-cooled tile walls are also finding favor because of lower first cost, low maintenance and great cooling effect. Bare tubes as part of the boiler are backed by sectionally supported tile. The tile is water-cooled on the fire face and either insulated or air-cooled on the rear face. Such walls have been used with success in the Toronto (Ohio) Station, the Long Beach (Calif.) Station, and at the Deepwater Station.

In selecting a type of wall for boiler furnaces the engineer should consider the service requirements of the boiler, the type of equipment selected for burning the fuel, and the economics of the plant operation, including fixed charges on the investment.

If the furnace is to be stoker-fired and is to be designed for a moderate maximum heat liberation, air-cooled walls should prove quite satisfactory. If the maximum heat liberation is greater than 25,000 B.t.u. per cubic feet per hour, then water-cooled bridge walls should be considered and a certain amount of water-cooling of the side walls, depending on the maximum rate of combustion. The air, after passing through the side-wall cooling ducts, should be returned to the furnace for combustion, thus reducing radiation losses.

WHEN pulverized coal, natural gas, fuel oil, or kiln-dried wood refuse is to be burned, the problem is somewhat different. Rates of heat liberation per cubic foot of furnace, length and form of flame, load factor of the boiler, fusion temperature of the ash, and design of the boiler with respect to the extent and position of radiant heating surface exposed to the furnace should be carefully studied. Furnace walls should have less water-cooling surface if the load factor is low and the boiler must be operated at times at low ratings. On the other hand, if a high load factor is possible and the boiler will at all times be operated at high ratings, more water cooling of the side walls is justified.

Present engineering practice indicates that there is a distinct field for air-cooled supported side-wall construction, and another field for water-cooled side-wall construction, and that in many cases combinations of the two types may be used to advantage.

. . . RIGHT OUT OF THE PLANT . . .

Voltage Regulator Made From Spare Parts

IN A large factory a 35-kw. motor-generator set has been in use for several years. The generator is an old type machine with poor voltage regulation. The day load consists mainly of direct-current hoists and arc lamps for blue printing. The fluctuating load caused wide variation of the line voltage, and it was decided that some means of regulation was necessary.

It was decided to build a regulator in the shop from spare parts. The vibrating type was chosen as being simplest to construct and maintain as against a motor-driven type. After some experimenting it was found that a 550-volt alternating-current compensator release coil would function excellently as a master solenoid, two 110-volt alternating-current release coils being used as secondary solenoids, in series with 110-volt, 50-watt mill-type lamps.

Operation of the regulator is as follows: Referring to the diagram, solenoid *A* is connected across the 110-volt bus on the switchboard through fuses. The pull of its core is against adjustable springs. As the voltage drops the pull of the springs overcomes the pull of the coil and contact *B* is closed, shunting the secondary solenoids *C* out of the circuit and allowing the carbon contacts to close. This short circuits the field rheostats, and the consequent building up of the voltage again draws the core of the master solenoid down against the spring and opens contact *B*, cutting the secondary coils again into the circuit. The rheostat is again inserted into the circuit, the dropping voltage operates the master solenoid and the cycle is repeated as long as the regulator is on the line, the vibrations being very rapid. The master contact can be adjusted to give regulation within 5 volts from no load to full load.

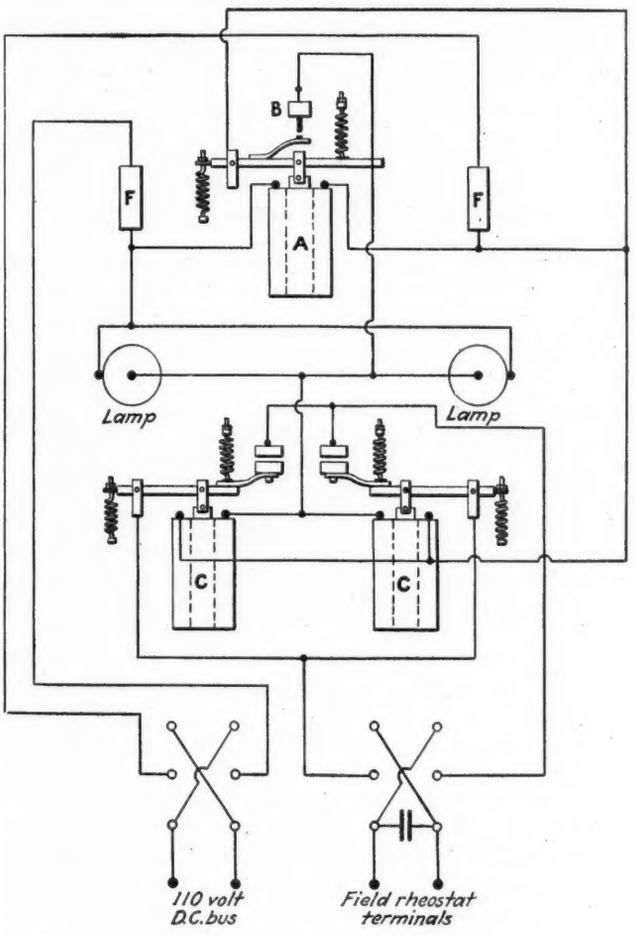


Diagram of connections of improvised voltage regulator

In making up the apparatus a slate panel 13x18x1 in. was used for mounting, and the regulator was inclosed in a steel cabinet 16x20x6 in., with plate glass front door. Regular release coil casings were used to hold the coils on the panel. Armatures, springs, brackets and gearings were made from standard repair parts of vibrating gongs, as also were the contacts for the master relay. Secondary contacts were standard carbon blocks as used on our electric trucks. Fifty-watt mill-type lamps were chosen as resistors because they could easily be replaced from stock. A condenser is placed across the carbon contacts and transfer switches are installed in the line to reverse the direction of the current periodically.

In eighteen months' continuous operation it has been necessary to replace the master contacts and the carbon contacts only twice. All parts used in the regulator are standard and can be replaced immediately from our maintenance stock.

Before the regulator was installed it was necessary to adjust the voltage by hand when the arc lamp load went on, and if there was no attendant in the vicinity at the time a messenger had to be dispatched to request us to make the adjustment.

ELLIS MILLS.

Toronto, Ont.

The Boiler Room Bonus

IN THE Jan. 28 number the question was asked "What Has Happened to That Boiler Room Bonus?" It may be of interest to some readers of *Power* to know how the bonus system will work if given a fair trial. It is used and well thought of in one power house with which I am familiar.

The plant in question is an industrial power house supplying various items, among which are compressed

air, and drinking water, pumping all water for general use from a private supply, high- and low-pressure steam for manufacturing purposes, together with an electrical output of over 7,000 kw. per hour during the day period. The plant, a war-time proposition, is in good condition. The boiler room equipment consists of eight 6,000-sq.ft. water-tube boilers, served by underfeed stokers.

The fuel proposition is rather a difficult one, run-of-mine bituminous coal being used. Fuel is bought on a reciprocity basis, and while not exactly of poor quality, it does vary a great deal. A crew "all set" to fire one kind of fuel suddenly finds firing methods will have to be changed to suit another coal. Boilers are operated at an average rating of 145 per cent for the month. During the day, when the load is the heaviest, the rating is 180 per cent of normal.

Boiler efficiency was considered too low, and, to add to the difficulties, the operating force was asking for more money, although it was thought their work did not justify it. The problem was to pay a higher wage and at the same time reduce costs. A search of the plant records showed an average boiler efficiency of 68½ per cent over a period of three years, from which it was determined that 69 per cent efficiency would be the figure to use as a set-up for a bonus.

How to raise the efficiency and get uniform operation on all three shifts was another question. As the plant was equipped with a good feed-water meter, and each stoker was served by an individual coal scale, it would appear simple, just to take readings at the beginning of each watch and figure the efficiency. This was tried to no avail; each watch started to see what it could do without any consideration for the one which relieved it. All fires were left as light as possible without danger of going out; the water level would be raised as high as it could be without sending any over with the steam. One misguided engineer on the night shift hit upon the brilliant idea of a liberal blowdown. By this he raised the evaporation for his shift to 17 lb. of water per pound of coal. All of which showed that individual competition was undesirable and that co-operation must be had.

When the bonus system was first inaugurated some slight improvement was made, but it did not hold steady, and it became apparent that a method must be adopted to show definitely what was going on, as a difference in opinion existed as to the best method of operation. A CO_2 recorder was installed, and while a great deal of information was obtained as to furnace conditions it could not be kept operating with a reasonable amount of maintenance and was found to be too delicate an apparatus to be of any great service; also, CO_2 was not considered the real answer to the problem.

Next an air-flow steam-flow meter was installed, and given a thorough test over a period of four months. This instrument was found to be a fairly reliable guide as to furnace conditions and proper combustion. All boilers were equipped with them.

It was found that better results could be obtained with inexperienced help who would be governed by the meter indications and do as they were instructed, rather than with so-called experienced firemen who were determined to follow old-fashioned ideas as to proper firing methods.

To participate in the bonus the three firemen, one on each shift, the three engineers, together with the boiler room engineer, who is in charge of the boiler room during the day, directing the maintenance work as well as the operation, were selected. The question as to how much to give and how to divide the bonus was then considered. As the boiler room engineer is the highest-paid man and the firemen are the lowest, it seemed more logical for all the men to share alike rather than pro rata according to their pay. A schedule was drawn up to pay each man 1 cent per hour for each ⅕ per cent increase over 69 per cent, the base efficiency established. Thus 70 per cent efficiency for the month will mean that each man draws a bonus of 5 cents per hour for the time he works; 70.6 per cent 8 cents per hour. It was also agreed that should the efficiency be raised to 73 per cent or over there will be a readjustment of the scale and the men will get a substantial increase above the rate now in effect.

The coal is sampled by each fireman taking one shovelful from the center and one from each end of the stoker hopper within one hour after going on watch. This sample is put in a large covered box mounted on a truck. At the end of each week the entire sample, about 1,200 lb., is ground and quartered in a motor-driven pulverizing mill. The final sample, 6 lb., is divided, one half being sent to the laboratory for analysis, the other portion being retained in case a recheck is necessary.

In conclusion, it can be said that the bonus system in this plant is working satisfactorily for all concerned. The employees are drawing a substantial amount and are striving to increase it. The indications are that an efficiency of 73 per cent will soon be had, which will mean that each man will draw a bonus of about $45 per month. The owners will receive about 50 per cent of the entire savings, out of which they agree to spend a generous amount in keeping the equipment up to date. They have already expended some $6,300 for draft gages, steam meters and damper regulators. The idea being carried out is to determine if any appliance will save 25 per cent of its cost yearly. If so, its installation is considered. From the results obtained, the boiler room bonus appears to be a decided success in the plant under consideration.

Bridgeport, Conn. P. R. WILSON.

Leveling a Horizontal Engine

REFERRING to the item "'Leveling a Horizontal Engine" that appeared on page 245 of the Feb. 18 number, I should like to offer the following comments:

In beginning this operation, place the engine bed on the foundation over the anchor bolts. Then place the leveling wedges, three in number, one on each side of the bed at the cylinder end, the other at the crank end near the center. Next, place a true spirit level on the bottom of the crosshead guide and adjust to this level by means of the wedge at the crank end. Then set the bottom half of the main bearing in position, put a true spirit level on the bearing, and adjust for level by driving the wedges on either side at the cylinder end. By following this method the bed is leveled quickly and at the essential points. Next, place the shaft in position, and level and square it with a line through the cylinder and crosshead guide. This being done, recheck the bed and shaft for level and when found to be true place additional wedges under the bed to retain the true level. Then grout the bed in that position.

The foregoing has been followed for many years by a manufacturer's service engineer, and is customary practice by erectors, because of accuracy, speed and economy, and, most important, permanency of setting.

San Angelo, Texas. M. G. MCCULLOUGH.

Use for Heat Exchanger With Purchased Steam

WHILE discussing with a visiting engineer in my plant the relative merits of purchasing steam from street mains for large office buildings and hotels, the following idea for reducing steam costs was brought up:

As practically all customers of the central heating plant either allow the condensate to go to the sewer or to a return line to the main boiler plant, they are either throwing away 10 per cent of the heat in their steam or giving it back to the steam company after they have bought and paid for it on a metered basis. These buildings usually have a demand for hot water, and this uses live steam as the heating medium, taking water at 40 to 50 deg. from the city mains. Since they realize only 970 B.t.u. from each pound of steam they buy, it follows that the installation of a heat exchanger which would use the heat in the condensate to heat the water for building use would save practically 10 per cent by cooling the condensate 100 deg.

This would, in some cases, react against the main heating plant, but could be offset by installing hot-water storage capacity, which would permit shutting off live steam to the heaters during the hours of maximum steam flow to the building heating system, reducing the peak load on the central plant. Naturally, since during the peak hour of building heating the heat exchanger is delivering hotter water, the use of live steam make-up can be restricted to off-peak hours. A. F. SHEEHAN.

Springfield, Mass.

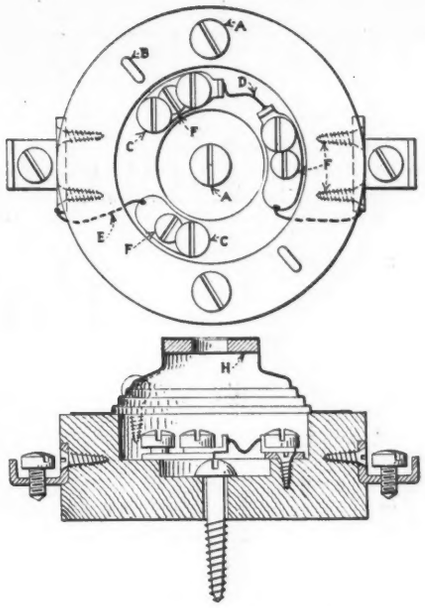
Ancient Electrical Wiring Equipment

IN THE Oct. 22, 1929, number of *Power*, I read a comment on Light's Golden Jubilee at Dearborn, Mich., to commemorate the fiftieth anniversary of the perfection of the incandescent lamp by Thomas Edison. I understand that most of the original equipment used by Mr. Edison fifty years ago was again used in his reconstruction of the electric light bulb. This equipment must have been interesting to those who were fortunate enough to see it.

The use of electricity is so widespread and commonplace there is a feeling that we always had it. I can remember when the burned-out lamps used in street lighting were collected as souvenirs. Not so many years ago it was a question whether houses already built should be wired or not. The plant where I am now employed was about the first in this district to have electric lights in the factory, the electricity being generated by an Edison bipolar dynamo No. 212.

I have a wooden-body cleat-type rosette which was put in with the original equipment, and I call it one of the seven wonders of the electric age, because it was used for years without giving trouble. The accompanying sketch and description of the rosette may be of interest.

Referring to the sketch, the base is made of maple wood without even a coat of paint for insulation. Wood screws *A* are used to fasten the rosette to the ceiling. Screw eyes *B* hold the cap to the base. The lamp cord is fastened to the binding screws *C*. *D* is a fuse wire, only one being used. Bare copper wires *E* were soldered to the outside lugs, carried through the wooden body and soldered to the inside terminals. Wood screws *F* fasten the brass terminal plates to the body. *H* is a fiber washer on the inside of the brass cap, the only piece of insulation in the whole fixture. To put the cap on the base the screw eyes were passed through slots in the cap and then given a quarter turn.



Details of old-style rosette

With this type of equipment was it any wonder that we heard so often, "Cause of fire—defective wiring."

Rockland, Mass. BURTON W. WHEELER.

Selecting a Pump

I NOTICE on page 406 of the March 11 number a question concerning the advisability of installing a triplex or a centrifugal pump for a capacity of 500 gal. per minute against 172 ft. total head. As the editor points out in a footnote, it is most surprising how the efficiencies vary so greatly in the different answers received.

Another curious point is that no speed above 1,800 r.p.m. was considered for the centrifugal, and it would be unusual for a pump of this type to show an efficiency higher than 70 per cent for the head and capacity given at a speed not exceeding 1,800 r.p.m.

A two-pole, sixty-cycle motor of the size required is standard practice, and they are built by almost all the principal manufacturers. I know of a case where three 750-hp., 3,600-r.p.m. motors direct-connected to centrifugal air compressors have been operating six years without giving trouble.

With a centrifugal pump operating at a full load speed of, say, 3,450 r.p.m. an efficiency of 75 per cent could be obtained at the given conditions, and approximately 29 b.-hp. would be required to drive it, whereas a unit at 1,750 r.p.m. with 70 per cent efficiency would require 31 b.-hp.; moreover, the high speed would mean a considerably cheaper pump.

It is a general practice to install high-head boiler-feed pumps operating at this speed where sixty-cycle motors are used for driving them. R. N. AUSTIN.

Toronto, Ont.

From Among Readers' Problems

Conducted by
L. H. MORRISON

SIZE OF CONDUCTORS—*What size of conductors will be required to transmit 1,600 hp., at 0.75 power factor, 15 miles with a loss of 7 per cent of the power generated in the line; the circuit to be three-phase with 11,000 volts at the generator, conductors spaced 36 in. apart? Also, what will be the per cent regulation?* R.M.S.

With 11,000 volts at the generator the voltage to neutral of a three-phase circuit will be 11,000 ÷ 1.732 = 6,350. Assuming 15 per cent regulation, the volts E to neutral at the receiver end of the line will be 6,350 ÷ 1.15 = 5,520. The watts W = hp. × 746 = 1,600 × 7.46 = 1,193,600, and the current I per wire, when the power factor is 0.75, is $I = W \div 3E \times P.F.$ = 1,193,600 ÷ (3 × 5,520 × 0.75) = 96 amp. Allowing the loss in the line to be 7 per cent of the power generated, the watts loss per wire is $W_n = \frac{W}{3} \times \frac{0.07}{0.93} = \frac{1,193,600}{3} \times \frac{0.07}{0.93} = 29{,}947$. Resistance per wire $= W_n \div I^2 = 29{,}947 \div 96 \times 96 = 3.25$ ohms; and the resistance per mile is 3.25 ÷ 15 = 0.217 ohm.

The nearest size standard wire is a 250,000-circ.mil conductor, which has a resistance of 0.2253 ohm, making the total resistance of one wire equal 0.2253 × 15 = 3.38 ohms. With conductors spaced 36 in. apart, the inductive reactance in ohms, at 60 cycles, per mile of single 250,000-circ.mil conductor is 0.626, making a total of 0.626 × 15 = 9.39 ohms.

Knowing the receiver voltage E, the generator voltage Eg is found by the formula,

$$Eg = \sqrt{(E \cos \Theta + IR)^2 + (E \sin \Theta + IX)^2}$$

where R is the resistance ohms and X the reactive ohms of one conductor, and Θ the angle corresponding to the power factor in the circuit. For a power factor of 75 per cent cos Θ = 0.75 and sin Θ = 0.66. Then

$$Eg = \sqrt{[(5{,}520 + 0.75 + 96 \times 3.38)^2 + (5{,}520 \times 0.66 + 96 \times 9.39)^2]} = 6{,}370 \text{ volts}$$

Per cent regulation =

$$\frac{Eg - E}{E} \times 100 = \frac{6{,}350 - 5{,}520}{5{,}520} \times 100 = 15 \text{ per cent.}$$

This value is close enough for all practical purposes. It should be noted that there is no direct method of making these calculations. A certain per cent regulation is assumed and the calculations made. If this does not come close enough, another value is assumed and the calculation made again until the correct value is obtained.

LOWER ALLOWABLE PRESSURE REQUIRES LARGER SAFETY VALVE.—*Two boilers are of the same dimensions throughout and each is provided with the same size of grate, kind of fuel and draft, and the temperature of feed water in each case is to be 200 deg. F. One of the boilers is allowed to carry a working pressure of 50 lb. gage and the other 150 lb. gage. Which should be provided with the larger safety valve?* E.L.

The boiler that is allowed the lower pressure should be provided with the larger safety valve. From the identity of the boilers and settings, it is to be presumed that each will transmit the same amount of heat in generation of steam. A pound of steam at 50 lb. gage, or 65 lb. abs., contains 1,178.5 B.t.u., and for generation from feed water at 200 deg. F. each pound would receive 1,178.5 — (200 — 32) = 1,010.5 B.t.u.

A pound of steam at 150 lb. gage, or 165 lb. abs., contains 1,195 B.t.u., and for conversion of the feed water into steam at this pressure each pound must receive from the boiler 1,195 — (200 — 32) = 1,027 B.t.u.

Therefore, for the same heat generated by the furnace and transmitted by the boiler, there would be $\frac{1,010.5}{1,027}$, or about 98 per cent as many pounds of steam generated at the higher pressure.

Napier's approximate formula for the discharge of steam from a safety valve is: Flow in pounds per second = absolute pressure × area in square inches ÷ 70; that is, the escape area required is directly as the weight and inversely as the absolute pressure, so that the safety valve for discharging steam at 165 lb. abs. would need to have only 98 per cent of $\frac{65}{165}$, or about 40 per cent as much area of opening as for discharging as much steam as would be generated at 65 lb. abs. for the same amount of heat transmitted by the boiler.

This is covered in the A.S.M.E. boiler code, which gives a table of safety-valve capacities. For example, a 4-in. valve will house 2,839 lb. of steam at 50-lb. gage, and 6.128 lb. at 150-lb. gage.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

THE heating system for our ten-story building was recently reconditioned. Orifices were installed in the radiator inlets and a pressure-regulating valve was placed in the main from the boilers. Under these conditions are thermostatic traps still necessary at the radiator outlets? R.A.R.

IT IS my experience that dumping traps are more dependable than thermostatic traps. On an installation of this sort it has been common practice for many years to use a vacuum pump in the cellar for the purpose of removing condensate and lowering the temperature of condensation in the system. Theoretically, this would increase the efficiency of the heating system. In actual practice, however, it does not always work out that way. Failure of any trap is apt to allow steam to blow through the system without condensing, making it impossible to maintain a vacuum unless a stream of cold water is injected into the condensate line. Failure of traps will also make it impossible to cool down a section of the heating system, due to the vacuum created by condensation in the section sucking steam out of the condensate line.

A successful system for an installation of this kind in a ten-story building supplies heating steam to all floors

above the third with dumping traps, dropping the condensate by gravity to the heating coils on the first three floors, thus making them hot-water radiators. A non-syphon overflow line connected to these radiators carries the cooled water down to the sewer or back to the power house.

The advantages of the system described above are self-evident, as the heat of the liquid is used for the first three floors, making a reduction of approximately 30 per cent in the amount of steam required to heat the entire building.

KENNETH C. MONROE,
Plant Engineer,
Bridgeport Brass Co.
Bridgeport, Conn.

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ALL two-pipe radiators should be equipped with thermostatic traps regardless of orifices in the radiator inlets. If the radiators are equipped with orifices, traps are not needed when the radiators are fractionally heated, which is the condition existing during most of the time. Whenever the heating requirements are such, however, that the radiators must be filled with steam, traps are necessary to keep steam out of the return mains. This condition exists every morning during the warming-up period and at every other time when the outside temperature is such that a full radiator of steam is required to maintain the desired building temperature.

Steam should be kept out of the return mains at all times, because of the heat loss from the piping in places where heat is not needed and because steam in the return mains in many cases interferes with the flow of condensation. This results in water-hammer and in failure of parts of the system to heat properly.

STERLING S. SANFORD,
Heating Engineer,
The Detroit Edison Co.
Detroit, Mich.

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WE HAVE been running nearly four years with orifices in the radiator inlets without traps on the returns and have not had the least trouble. We attribute this to the accuracy of the control and orifice. With either poorly made orifice or a poor regulator you may not be able to do it. I doubt if an ordinary reducing valve is good enough. A description of this heating system was published in the Nov. 6, 1928, number of *Power*.

JOSEPH PATON.
Bloomfield, N. J.

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THE question of whether radiator traps are necessary in an orifice type heating system is a matter of how well such a system is designed. If it be granted that all of the inlet orifices and radiators are so sized that the steam passing into the radiator will be condensed there, then thermostatic traps should not be necessary. If the system is not zoned additional radiation should be provided to condense the steam where zoned heating occurs.

JOHN CASSIDAY.
Jersey City, N. J.

IF THE radiation is sufficient and properly proportioned to heat the assigned space with a steam pressure in the radiators of about that of the atmosphere, thermostatic return traps are not necessary, if no other problems are involved.

However, this does not seem possible in a ten-story building, but not knowing what the building is used for it is not possible to answer with any degree of accuracy.

A ten-story building usually has different exposures, various infiltration losses, possible heat gains, active and sedentary types of occupants, and there are other conditions that would tend to vary the heating load in different parts of the building at any time. So it would be difficult to provide ample heat in one part of the building without overheating another, and steam will leak to return lines unless there are thermostatic traps on the radiators.

A ten-story building should be zoned to compensate for the shifting sun, high winds and numerous other conditions, but the question does not mention if the system is zoned, so I assume it is not. To heat a building with one control near the source of supply requires thermostatic traps on all radiators to prevent the returns on the sheltered or lee side from filling with steam; without thermostatic return traps an approach of a peak load would be an approach of trouble.

So much for the radiation as a whole. There are certain features of individual radiators that should be considered. An important detail that is often overlooked, when considering the possibility of eliminating thermostatic return traps, is that when an orifice is at the inlet of a radiator a continuous passage should be provided for the steam through all the radiator to prevent air binding. Top-connected, water-type radiators are essential for best results, if thermostatic traps are discarded. When steam-type, bottom-nipple, radiators are used without a thermostatic return trap, a straight blow-through of the steam jet from the orifice to the return is experienced, with an air pocket or hard-to-heat surface at the top of the radiator. As the velocity in cold weather is too high to permit the air and steam to stratify by gravity, the blocking action of a thermostatic trap is required with this type of radiation, to allow the steam and air to separate and to properly heat the radiator.

I will assume that the system has a vacuum return line and it is desired to remove the worn or obsolete thermostatic radiator traps.

In a ten-story building many complications arise and much trouble is ahead from "short circuiting," if a vacuum pump is operated without thermostatic traps on the outlets of radiators.

If the return piping is large enough, and any lifts or pockets that exist are eliminated and the return lines properly pitched, the system may be operated with good results as a dry-return gravity system, with an open return tank, without any thermostatic traps on the radiator outlets.

If this is not possible and no provision is made for zone requirements, or if it becomes necessary to heat with a pressure of much above the atmosphere, thermostatic traps must be used on all radiators.

WILLIAM J. ANDERSON,
Pipe Shop Foreman,
E. W. Bliss Co.
Brooklyn, N. Y.

—❖—

THERMOSTATIC traps are not necessary at the outlet end of radiators when the steam supply is through an orifice of a size to correspond with the steam pressure and the size of the radiator.

Our company, which supplies heat to about 1,500 buildings, has had much experience with this method of control and regards it as the best and most economical in the use of steam.

For best results the return line should be maintained at atmospheric pressure. If a vacuum is maintained, the effective pressure is the gage pressure plus the vacuum, and the orifices must be accordingly reduced in size.

We prefer the orifices to be right for about 5 lb. gage maximum steam pressure. If the pressure is raised higher there will be some noise from the steam entering the radiator. When the orifices are so arranged, by reducing the pressure to 1 lb. on mild days only about 20 per cent of each radiator will heat. This will apply to the radiator closest to the steam supply as well as to the most distant one, a desirable feature not possible with any other system.

We use an ordinary needle valve with proper size drilling for an orifice, installed so the pressure will be against the stuffing box. By closing and opening the valve any obstruction will be forced through the orifice, or the bonnet may be removed from the valve and the dirt cleaned out without disconnecting the piping.

LEWIS JONES.
Overbrook, Pa.

A Question for Our Readers

OUR uniform steam engines are supplied steam at 150 lb. gage. It is now planned to build a new boiler house and install additional power in the shape of a steam turbine. Will we have difficulty if the uniflows are supplied with steam at 300 lb. pressure and 100 deg. superheat? S.W.M.

Suitable answers from readers will be paid for and published in the April 29 number.

THE ENGINEER'S

The Power System

ELECTRIC SYSTEM HANDBOOK. *By C. H. Sanderson and seven others. Published by McGraw-Hill Book Company, 370 Seventh Ave., New York City, 1930. Semi-flexible binding; 4½x7 in.; 1,167 pages; 887 illustrations; 88 tables. Price $5.*

TO SUCCESSFULLY OPERATE a power system requires a knowledge of practically every kind of power equipment. Not only do operating engineers come into contact with all types of generating equipment and its control, but also motors of every type. To these may be added transformers, rotary converters, rectifiers, frequency changers, storage batteries, synchronous condensers and line equipment. These equipments represent the whole range of voltages from the lowest to the highest and both underground and overhead transmission. It was to meet the needs of the men who are responsible for this vast collection of apparatus that this book was written.

The work is divided into fourteen sections, each dealing with a specific branch of power system design and operation. The first section discusses the fundamental principles of the different kinds of electrical equipment, including direct-current and alternating-current generators, transformers, synchronous converters, frequency changers and synchronous and static condensers.

In Sections 2, 3 and 4, auxiliary equipment, such as switches and circuit breakers of various kinds, meters, voltage regulators, lightning arresters, reactors, switchboards and direct-current and alternating-current motors, is covered. These four sections have been written as an introduction to the following sections, on generating stations: transmission systems, alternating-current substations, railway substations, direct-current substations for light and power, and distribution systems. Section 11 deals with the protection of electric apparatus, circuits and systems. An important part of the work on any electric system is the inspection and maintenance of the equipment, and this subject is treated in Section 12. Section 13 comprises 40 tables for which the engineer or operator has the most use in his studies and daily work. Standard definitions of the American Institute of Electrical Engineers are given in Section 14.

The foregoing indicates that the whole story of the power system is told in logical sequence. The subjects have been presented in a form that can readily be understood by those not possessing a technical education. In presenting the material, first the component parts of the electric system have been described, then the relation one to the other, and features of electric power system design and operation are discussed. The book has been written for students of engineering, operators, inspectors, maintenance and test department employees and engineering draftsmen. To them and others interested in power system design and operation this book contains a wealth of information presented in an easily understood and usable form.

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Heat Transfer

DER INDUSTRIELLE WÄRMEÜBERGANG. *By Dr.-Ing. A. Schack. Published by Verlag Stahleisen, Düsseldorf, Germany, 1929. Cloth; 6x8 in.; 411 pages, 41 diagrams and 37 tables. Price, $4.50.*

THE NAME of Dr. A. Schack is already well known in this country in connection with the difficult problem of radiation from gases. He was the pioneer who first called attention to this important question and gave it quantitative values.

Based on the practical work of metallurgical engineers, the present book draws freely on recent research of German engineers in other fields, and the author has succeeded in blending theory and experience in a concise and logical whole. The theory of similitude in convection heat transfer evolved from the works of Reynolds, Prandtl and Nusselt precedes the empirical evaluations. The problems of heat transfer in cases of unsteady or fluctuating heat flow are well set forth, and practical solutions are given. Heat transfer by condensing vapors is well worth a close study. Especially well written is the chapter on radiation, in which Dr. Schack is one of the foremost experts.

An outstanding feature is the concise and systematic treatment of the subject. Unlike most of the general works on heat transfer, the consecutive problems are laid out in a logical way and do not present an array of disjointed and undigested facts. The empirical formulas of different authorities are well supported by experimental data, which helps to judge their correctness within the limits of the problem at hand. This book is well worth study by engineers already familiar with heat-transfer problems, but those accustomed to deal with such questions by a couple of movements on a slide rule will find the book overloaded with considerations of "minor" importance. Generous space is given to the sample calculations, and at the end a complete set of most important formulas is given.

In general, it should be recommended as a textbook on heat transfer to help to establish right trends and opinions in dealing with definite problems. However, for a successful design of a particular heat-exchange apparatus more detailed knowledge and experience is necessary. N. C. ARTSAY.

Wiring Practice

ELECTRIC WIRING. *By Albert A. Schuler. Published by McGraw-Hill Book Company, 370 Seventh Ave., New York City, 1930. Cloth; 5x7½ in.; 305 illustrations; 380 pages. Price, $2.50.*

PREPARED as a vocational school text, there are many practical suggestions in this book on problems pertaining to electric wiring. The work is divided into ten units: Splicing and joining conductors, bell wiring, annunciator wiring, burglar-alarm wiring, electric-light wiring, house-wiring plans, telegraph wiring, telephone wiring, and circuit testing. The treatment is entirely practical, mathematics having been avoided.

The first chapter shows how the various kinds of splices and joints used in wiring are made. In the chapters on wiring, principles are explained, and the operation and connections of equipment are shown. A simple test required when locating faults in wiring and identifying circuits is presented in the last chapter. Those wishing to familiarize themselves with wiring practice will find this book helpful.

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For Drawing Students

INTRODUCTORY MECHANICAL DRAWING. *By Clarence E. Townsend and Stephen F. Cleary. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City, 1930. 402 pages; 419 figures and 10 tables. Cloth 6 x 9 in. Price, $3.*

WRITTEN specifically to meet the requirements of engineering colleges for a text on introductory mechanical drawing, this book begins with a chapter on selection, care and use of drawing instruments and materials, and covers the elementary principles of mechanical drawing rather completely. No attempt has been made to encroach upon the field of design drawing. Such subjects as lettering and graphic representations are treated in considerable detail.

Part II of the book is divided into fourteen chapters and covers elements of detail drawing, development of working drawings, fits and finishes, dimensioning practice, assembly, outline and special working drawing and free-hand sketching. Part III is devoted to exercises and problems, and an appendix of twenty pages covers screw threads and machine fasteners, such as the various types of bolts, cap screws, dowel pins and keys.

BOOKSHELF

Business Engineering

THE SUCCESSFUL CONTROL OF PROFITS. *By Walter Rautenstrauch. Published by the B. C. Forbes Publishing Company, 120 Fifth Ave., New York City, 1930. Cloth, 6x9 in.; 239 pages, 23 charts. Price, $3.*

WRITTEN by a consulting engineer of wide experience in the problems of manufacturing industries, this book carefully develops the idea that business enterprises are capable of exact and revealing analysis—that an executive need not judge the activities under his control by rule of thumb, but may measure many of them with yardsticks that are no more vague than a surveyor's tape.

Imponderables remain in business of course, but it is safe to say that every decade sees fewer of them. Fifty years ago the exploitation of our vast natural resources could raise an untrained man to the stature of an industrial giant. He would find the going harder today. The successful business man of today builds upon accumulated experience—whatever tools and knowledge exist that are applicable to his business, he must avail himself of.

Modern methods bring every element of business into sharper focus and under closer control. Professor Rautenstrauch demonstrates how every phase of a business may be subjected to searching analysis; he deals extensively with costs and overhead; he shows that many of the characteristics of an enterprise may be learned from a study of the relations between fixed and variable costs and the selling level of a manufactured article; he points out what a balance sheet and a profit and loss statement may be made to reveal, and he outlines a practical budget system. Many charts and diagrams illustrate his statements.

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Scientific Data

HANDBOOK OF CHEMISTRY AND PHYSICS. *Fourteenth edition. Compiled by Charles D. Hodgman and Norbert A. Lange of the Case School of Applied Science. Published by the Chemical Rubber Company, Cleveland, Ohio, 1929. Artificial limp leather; 4¼x6½ in.; 1,386 pages. Price, $5.*

THIS ADMIRABLE handbook deserves increasing attention from the power engineer, as his work leads more and more into the fields of chemistry and physics. Any one at all familiar with book-making must be impressed with the stupendous amount of labor that has gone into this volume from its first edition through the various revisions to the present day. Closely packed with important constants and other fundamental data, it is quite free from "padding." The amount of ground covered in a practical way is astonishing.

Among the many additions to the fourteenth edition, the following will be of particular interest to power engineers interested in the scientific side of their work: Tables dealing with the heat of formation and heat of combustion of organic compounds; combustion constants for gases; heat of combination and combustion of representative coals; tables of coefficients of thermal expansion of metals and other substances; tables on the density of the elements, and on the physical constants of common minerals; percentage composition of anti-freeze solutions; a table of constant humidity of many compounds; special tables on the conversion of thermometer scales; a much-enlarged table of indicators; and complete interest and sinking fund tables.

The authors have devoted 155 pages to mathematical tables, 637 pages to general chemical tables, 136 pages to the properties of matter, 71 pages to heat. Illustrative problems at the end are valuable drills in chemistry and physics.

German Oil Practice

DIE ÖLBEWIRTSCHAFTUNG: Manual for testing, inspecting and handling of insulation and turbine bearing oils. *Published by the Vereinigung der Electrizitätswerke E. V., Berlin W. 62, Germany, 1930. Cloth; 6x8¼ in.; 137 pages. Price, $1.25.*

PUBLISHED by the Association of Electrical Power Plants in co-operation with the Division of Lubricants of the Union of German Steel Makers, this book contains a general description of insulating and lubricating oils, their properties, specifications, instructions for testing, handling, cleaning, drying, and organization of supervision. Standard forms for reports and tests are given, accompanied by a list of instruments, apparatus and chemicals necessary in a plant. Literature references on oils are complete up to 1930.

The book is excellent in its arrangement of chapters, division and nomenclature. It is a sort of practical code of instruction adopted by the member companies of the unions which published the book. A wealth of practical data is given for advisory purpose. The book is the result of the work done by thirteen foremost experts, but it is not self-contained, because it is an addition to a set of books which are supposed to be in every German power plant. However, the standardized German practice is well worth studying.

N. C. ARTSAY.

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Brief Reviews

THE FLOW OF WATER IN RIVETED STEEL AND ANALOGOUS PIPES. By Fred C. Scobey. Technical Bulletin No. 150 of the United States Department of Agriculture; 136 pages; illustrated. For sale by the Superintendent of Documents, Washington, D. C.; price, 30 cents.—The carrying capacity of pipes made of sheet and plate steel or iron as used in general service to convey water under pressure is discussed in this bulletin, which contains many tables and charts compiled from data obtained in a large number of field experiments.

MANILA AND WIRE ROPE. Safe Practices Phamphlet No. 26, published by the National Safety Council, 20 North Wacker Drive, Chicago, Ill., 1930; 16 pages, illustrated; free.—Here is a compilation of experience in accident prevention with manila and wire rope. It includes much valuable data on application and maintenance.

KEYSTONE COAL BUYERS' CATALOG AND MINE DIRECTORY, 1930 Edition Compiled and published by the McGraw-Hill Catalog & Directory Company, 475 Tenth Ave., New York City; 860 pages; price $15—To the comprehensive and authoritative information on more than 5,500 samples of coal from all parts of the country has been added this year an up-to-date mine directory. It is an indispensable book for coal purchasers.

TRADE STANDARDS OF THE COMPRESSED AIR SOCIETY. Published by the C.A.S., 90 West St., New York City, 1930; fourth edition; 47 pages, illustrated; price, 50 cents.—An authoritative reference work on standards for the compressed-air industry.

NATIONAL SURVEY OF FUEL OIL DISTRIBUTION, 1928. By E. B. Swanson. Published by the Bureau of Mines, Washington, D. C., 1929; 28 pages; free.—Statistical data on the distribution, by states and industries, of gas oil and fuel oil in the United States during 1928.

PUMP-FAX. Compiled by F. G. Switzer. Published by Goulds Pumps, Inc., Senaca Falls, N. Y., 1930; 64 pages, illustrated; free.—A valuable handbook of data and information on the characteristics, installation and operation of pumps.

High-Pressure Progress Discussed

at Metropolitan A.S.M.E. Meeting

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Things Talked About

Temperatures . . .
Pressures . . .
Central stations . . .
Industrial plants . . .
Progress in Europe . . .
Tube thickness . . .
Centrifugal feed pumps . . .
Underground heat storage . . .

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PROGRESS in high steam pressures, in America and abroad, was the subject of interesting discussion at a meeting of the Metropolitan Section of the A.S.M.E., held in New York City, March 25.

THE PAPER of the evening, written by J. B. Crane, high-pressure specialist of the Combustion Engineering Corporation, was presented in his absence by Otto de Lorenzi of the same organization.

In his paper Mr. Crane suggested that some of the turbine manufacturers may soon solve the problem of throwing out moisture from the lower stages of turbines, thus increasing the expansion range that can be covered without reheating. He thought that commercial temperatures of 850 deg. are not far away, and suggested that 1,000 deg. temperature may be practicable with alloy superheater tubing. He referred to the growing use of evaporators as reducing valves in process plants.

The next five years, Mr. Crane said, will add a large amount of operating experience to that already obtained on high-pressure plants, the experience thus far obtained indicating less trouble than was anticipated. It was his belief that "we shall soon see industrial centers in which power houses or a series of power houses will generate power for high pressures and deliver steam to industry for process work, in this way contributing to more successful methods of producing materials, by providing a large amount of power at a minimum cost, combined with the necessary amount of heat for process work. This will undoubtedly be combined with waste-heat boilers where they can be advantageously used."

IN EUROPE, according to Mr. Crane, the development of high pressures has been along different lines. Most of the European designs have been made on the basis of eliminating expensive forged-steel drums. To do this the pressure has, in most designs, been increased to get as close as possible to the critical point. In America the central stations have led in the application of high pressures. The opposite is true of Europe, where the industrial plants have been the leaders in this field.

Recent developments in the Benson, Loeffler, Atmos and other foreign high-pressure boilers were described by Mr. Crane, whose paper was followed by an active discussion in which many points of interest were brought out.

GEORGE ORROK, consulting engineer, reminded his hearers of the early high pressure pioneers, particularly Perkins.

In connection with tubes for high-pressure boilers, Mr. Orrok observed that thinner tubes might actually be safer than those now in use with dimensions fixed by the A.S.M.E. boiler code. There is a tendency, he said, to overlook the stresses set up by the temperature differential between the outside and inside of the tube. Actually, these stresses may be four times those caused by the pressure. Thinning the tube increases the pressure stress, but may, up to a certain point, decrease the temperature stress by a greater amount, Mr. Orrok said.

He pointed to the primary importance of the metal conductivity in this connection. Referring to the "international critical tables," he said that the existing conductivity data favor the use of low-carbon steel. Thus, due to this temperature factor, attempts to strengthen tubes by using stronger and thicker material might not be successful. Mr. Orrok felt, however, that published conductivity values may not be reliable.

He expressed the belief that it would soon become universal practice to protect the drums and high-pressure boilers from high temperatures.

MR. ORROK commented on high-pressure progress in Europe as revealed to him on recent trips of investigation. In the matter of temperatures, he reported a Loeffler superheater that appeared perfect after nearly 8,000 hr. of operation at a temperature of 930 deg. F. The steel used was 0.19 per cent carbon.

Mr. Crane had referred to the difficulties with centrifugal feed pumps at very high pressures such as those used with the Benson boiler. The existence of these troubles was confirmed in a discussion by Karl Mayr, New York representative of Siemens-Schuckertwerke, A.G. He said, however, that four firms in Germany are now developing pumps to operate up to 3,200 lb. and at least one of these is operating successfully when delivering 60,000 lb. per hour.

PERHAPS the most significant discussion was that contributed by F. W. Gay of the Public Service Production Co., Newark, N. J. Mr. Gay, with curves and data, argued that very large investment savings might be made in central stations by the utilization of underground storage in connection with high-pressure operation. He referred to the use of great caverns located in solid rock far below the surface of the ground. By the use of water at very high temperature and pressure the power-storage capacity per cubic yard would, he said, be four or five times that of a steam accumulator working at usual pressures. On the other hand, he felt certain that the cost per cubic yard would be a mere fraction of the accumulator cost, his estimate running around $4 or $5 per cubic yard.

The pressure, he said, should cause no difficulty since nature easily stores natural gas at 1,000 lb. pressure. He also emphasized the remarkable heat insulating qualities of great thicknesses of rock. A cavern 60 to 70 ft. in diameter and 100 ft. long, he computed, would meet the needs of a 100,000-kw. plant.

Mr. Guy's emphasis was on base-load storage rather than peak-load storage; he felt that the former has greater economic possibilities.

The usual procedure, he pointed out, would be to run the plant all night, bleeding all steam to the storage reservoir with none passing to the condenser. During the day deep-well pumps would deliver the hot water directly to the boilers. His curve showed that at higher pressures the heat in this storage water is a substantial proportion of the total heat in saturated steam, so that this supply represents a definite increase in steaming capacity. His figures seemed to indicate that this method of base-load storage gives best results at pressures around 2,000 lb. Above 2,000, he said, its application is rather for peak-load storage, which is an entirely different problem.

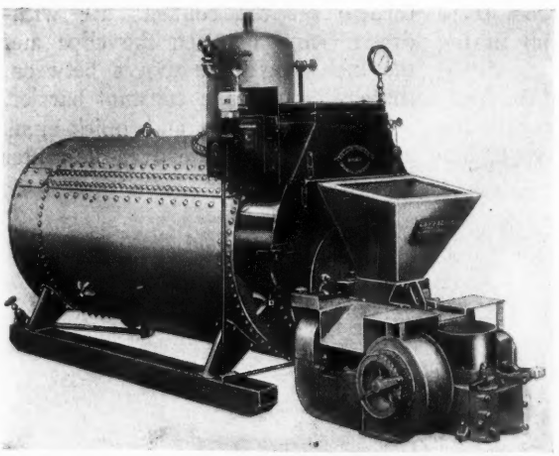
WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Underfeed Stoker for Scotch Marine Type Boilers

THE comparatively small firebox opening of the standard Scotch marine type of boiler has made it difficult to adopt any of the existing designs of stoker to this boiler.

This difficulty appears to be overcome in the new Leffel automatic underfeed stoker illustrated, which has been designed especially for this particular type of boiler by James Leffel & Company, Springfield, Ohio. The new unit is made in sizes suitable for boilers ranging from 150 to 2,000 sq.ft. of heating surface, and can be readily applied to existing as well as to new installations.



Typical installation of unit-type underfeed stoker with automatic electric control

Referring to the illustration, it will be seen that the various parts of the stoker are combined to form a complete assembly, which is placed in front of, and made to rest on, the same level as the boiler itself. The forced-draft fan is directly connected to the driving motor, with the reduction gear for the stoker ram drive in the center. The crank driving the ram revolves in a horizontal plane instead of a vertical plane, as is usual practice. By this design the gear reduction has been simplified and the space required between the motor and fan has been reduced.

Manual control of the forced draft air is by a damper on the air intake of the fan. Automatic control of the complete unit is effected by a pressure-switch mounted beside the combined starter and safety switch on the boiler smoke box.

Although the motor drive with complete electric control is standard equipment, steam-turbine drive can be furnished to meet certain installation requirements or where current is not available.

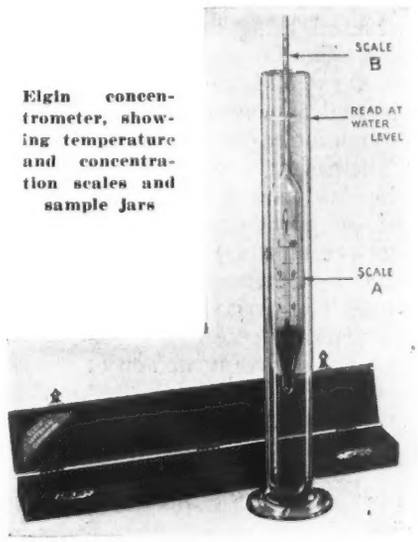
Concentrometer Indicates Concentration of Boiler Water

BLOWING DOWN boilers has been an uneconomical process, because it has been difficult to determine just how much blowing down should be done or how often it should be done. Two or three boilers in a battery may lose a different amount of water, if each is blown down a "gage," owing to differences in size or type. In a plant with three or four boilers it may not be satisfactory to blow down each one the same amount, or as often for each boiler, because water conditions may be different.

It is now possible to determine conveniently the concentration of boiler water by the new Elgin concentrometer, a meter recently developed by the Elgin Softener Corporation, Elgin, Ill. This instrument shows boiler concentration directly in grains per United States gallon. The concentrometer consists of a combination thermometer and hydrometer, the thermometer having a scale graduated from 80 to 100 deg. F. The hydrometer scale, which reads directly in grains per United States gallon, is calibrated for every 10 grains and has a range from 0 to 500.

A sample is obtained from the water column line after blowing out all stagnant water, about a quart being blown into a metal container, where it is allowed to cool. This is poured into the sample jar and the concentrometer is lowered into it and allowed to find its own level. When the sample has cooled to 90 deg. F., as shown by the thermometer, the hydrometer scale is read at the level of the water in the sample jar. As the equivalent concentration varies with temperature, all readings are taken at 90 deg. F. It is then possible to have all boiler waters upon the same basis of comparison.

The concentrometer with its case weighs less than two pounds. No scientific knowledge or experience in chemistry is required to use it. It affords a practical method of super-

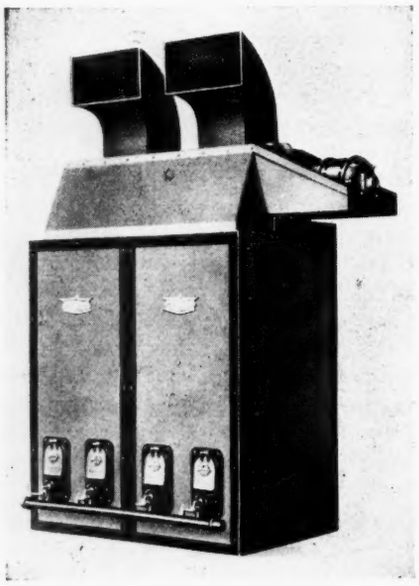


Elgin concentrometer, showing temperature and concentration scales and sample jars

vising boiler-water control that is adaptable to the smallest or the largest plant.

Gas-Fired Multiple-Unit Heater

IN THE type-V gas-fired warm-air heater now being put out by the Reznor Manufacturing Company, Mercer, Pa., two, four, six or eight combustion units can be grouped to



Type 2 UV gas-fired heater

form unit assemblies rated at 100,000, 200,000, 300,000, and 400,000 B.t.u. per hour. These figures divided by 240 give the equivalent steam radiation.

In the 2 UV unit illustrated, which is rated at 100,000 B.t.u., the base is cast iron; on the larger sizes angle iron is used, with the unit supported on two cross I-beams. Above the casing is mounted a housing containing the blower assembly, one fan and hood being used for each two units. The fan shaft, which operates at 860 r.p.m., is carried on ball bearings and is connected to the motor through a flexible coupling.

The casing of the heater proper is a double-steel wall with ½ in. air space. The gas burners, of which there are four per unit, are automatically operated by a thermostat and motor gas valve. The air fans are automatically started and stopped at a point after the burners have turned on or off, so that no cold air is circulated. This control is effected by a furnacestat or similar standard temperature switch.

Approximate over-all dimensions and fan capacities of the different assemblies are as follows: Front to back, all sizes, 36 in. Height to top of hood, all sizes, 87 in. Front width, type 2 UV 30 in., fan capacity 1,560 cu.ft. per minute; type 4 UV 54 in., 3,060 cu.ft.; type 6 UV 78 in., 4,575 cu.ft.; and type 8 UV 102 in., and 6,100 cu.ft. The discharge-air temperature is under 140 degrees.

Where sufficient headroom is not available to permit installation of the standard unit, a single-type fan may be set alongside of the heater, with down discharge and delivering the air to a concrete pit over which the heater and fan are set.

Automatic Loader for Skip Hoists

A NEW TYPE of automatic loader for skip hoist buckets, known as the full bucket control, has recently been added to the line of automatic loaders put out by the Link-Belt Company, 910 South Michigan Ave., Chicago, Ill.

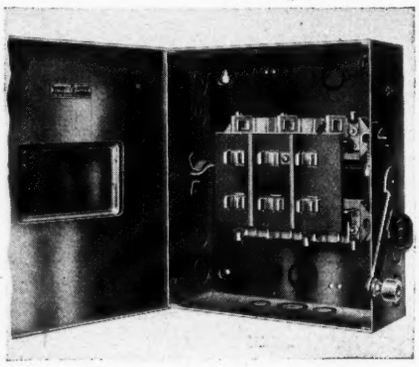
The new loader, shown in the accompanying illustration, has a simple attachment, which consists of a swinging plate so arranged that unless material is flowing through the chute in sufficient depth to maintain electrical contact, the skip hoist will not operate. In other words, there has to be sufficient material in the hopper to fill the bucket.

When the bucket reaches the loading position this loader permits the material to flow from the hopper until the bucket is full, when the mechanism causes the bucket to be hoisted, thereby moving the loader into its closed position, where it remains as the bucket continues to travel to the emptying point, and until it returns to the loading position, where it is again automatically loaded. The bucket continues to load and empty automatically so long as there is sufficient material the fill it.

The important constructional features embodied in the other types of loaders made by the company are incorporated.

Switch Designed to Eliminate Destructive Arcing

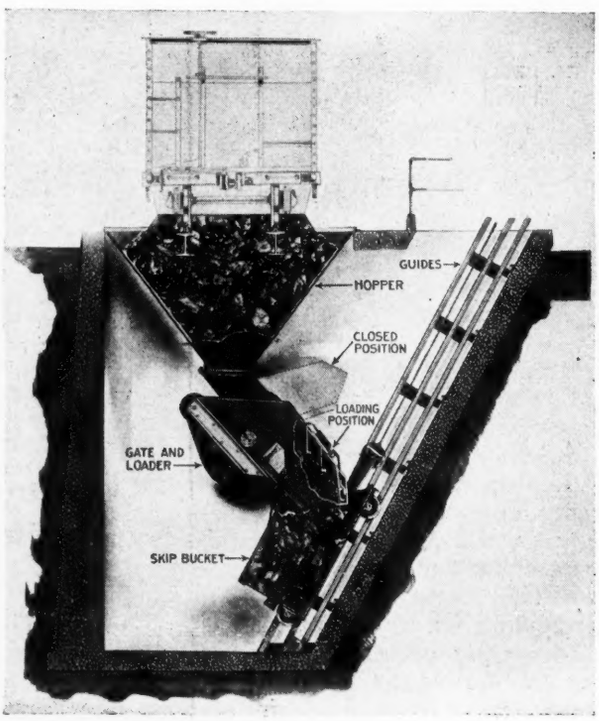
DESIGNATED "Noark Quadbreak," the new line of air-break switches recently introduced by Colt's Patent Fire Arms Manufacturing Company, Electrical Division, Hartford, Conn., is especially designed to diminish, and practically



Auxiliary door in front cover gives access to fuses

eliminate, destructive arcing. An outstanding feature is the switching action employed. Two contacts incorporated in an insulating slide are made to move endwise between two sets of clips. When the switch is thrown off the contacts are withdrawn from between the clips and the insulating slide moves between, thereby acting as a constant barrier.

The quick-make and quick-break mechanism is of the over-the-center



Typical arrangement of loader

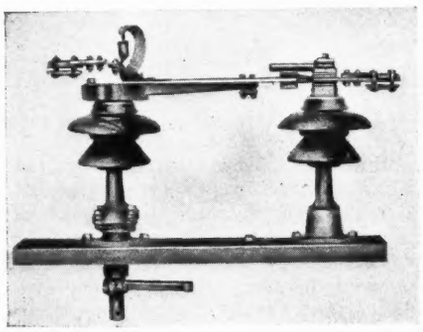
toggle-compression-spring type, embodying the safety feature that the spring may break in one or more places and still operate the mechanism satisfactorily.

An additional safety feature is in the cabinet design, which has an auxiliary cover in the main switch cover to provide access to the fuses without opening the main cover or front of the cabinet. The auxiliary cover has a sliding interlock, making it impossible to get at the fuses unless the switch is "off" or to throw the switch on when the fuse cover is open.

The switch is available in two types of cabinets, with or without the access door in the front cover, and in a number of capacities.

Gang-Operated Disconnect Switch

THE ILLUSTRATION shows an improved type of pole-top gang-operated disconnect switch, a single-pole element being shown. The switch is fitted with a solderless compression-type terminal lug, providing a convenient line connection. The switch is made in a number of ampere and voltage ratings and in both



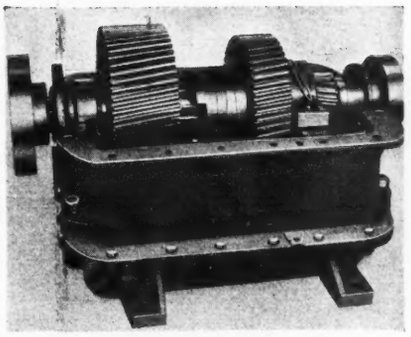
Disconnect switch rated at 15,000 volts and 600 amp.

hand- and motor-operated types, by Delta-Star Electric Company, 2400 Fulton St., Chicago, Ill.

Two-Speed Gear Unit for Stoker Drive

PROVISION for operation at two different speeds is a feature of a double-reduction gear unit for stoker drive brought out by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

In a three-section case, the high-



Inside of two-speed double-reduction gear unit for stoker drive

speed pinion shaft and a splined shaft on which the change gear arrangement is assembled are aligned directly above the shaft, on which are the intermediate gear and two slow-speed pinions each having a different number of teeth. Slow-speed pinions are integral with the shaft.

A cross member on the inside of the case carries one end of the high-speed shaft and one end of the low-speed splined shaft, the other ends of these shafts being supported by the ends of the case. Two gears of different size on the low speed shaft are mounted on roller bearings. Between them a sliding clutch manipulated by a lever from the outside of the case engages either of the gears. Anti-friction bearings and helical gears are used throughout, the gears and and bearings being lubricated by a splash system.

The unit illustrated has a ratio of 5.88 to 1 in the high speed and 12 to 1 in the low speed.

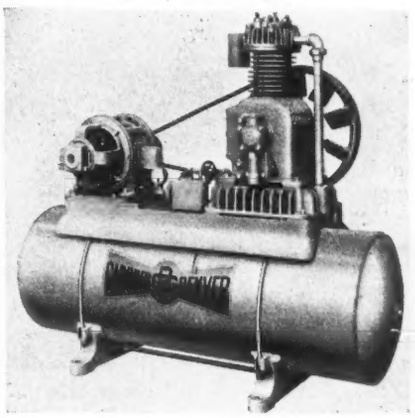
Welding Rod for Mild Steel Plates and Castings

AMONG claims made for the new Weldite C—No. 6 fluxed rod designed for carbon-arc welding announced by the Fusion Welding Corporation, 103d St. and Torrence Ave., Chicago, Ill., are that the welding speed has been substantially increased and the deposit is strong and ductile, being more readily machinable than deposits made with the usual filler rod used with the carbon-arc process.

It is also claimed that ease of manipulating the arc, due to the influence of the flux coating, which causes the arc to pull from the hottest part of the weld puddle rather than jumping to the colder edges, as is usually the case with the carbon-arc process, enables the operator to attain welding speeds considerably higher than is possible with ordinary bare filler rod. The rod is particularly adaptable to heavy section welding of mild steel, and gives weld deposits that are sound and strong.

Self-Contained Air Compressor Unit

IN THE A-C-E model air-cooled single-stage air compressor recently brought out by the Gardner-Denver Company, Quincy, Ill., a $3\frac{1}{2}$x4-in. duplex compressor and a 5-hp. motor attached to a common cast-iron base are mounted on the top of an air receiver. The unit has a displacement of 26 cu.ft. per min-



Compressor and motor are mounted on top of air receiver

ute, operating at 600 revolutions per minute.

An outstanding feature of the new compressor is inclosure of the suction and discharge valves in separate compartments. This prevents the air from being heated when passing through the intake valves. An automatic or hand-operated start and stop control is furnished as standard equipment and operated in conjunction with the Penn type pressure and moisture unloader. The unloader is set to cut in at 130 lb. and out at 165 pounds.

Lubrication is by the controlled splash system. A positive driven plunger pump on the outside of the crankcase supplies filtered oil to troughs under the connecting rods. The piston is fitted with a special oil ring and groove to prevent oil from passing over to the discharge lines.

Other features of the compressor are: V-type belt drive; a fan type of flywheel for circulating air across the cylinder; roller bearings; aftercooler in the compressor base; and a muffler for the suction opening.

NEWS of the FIELD

Spot News

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A LICENSE *for a 539,000-hp. hydro-electric project on the Susquehanna River at Safe Harbor, Pa., has been granted the Safe Harbor Waterpower Corporation of Holtwood, Pa., by the Federal Power Commission. Construction work has already been started on the development, which will involve an ultimate expenditure of $30,000,000.*

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DISCOVERY *of a new refrigerant, developed by Thomas Midgley, Jr., and Dr. A. L. Henne, has just been announced by the Division of Industrial and Engineering Chemistry of the American Chemical Society. Technically known as fluoro-chloromethane, the substance is a non-toxic, non-inflammable, clear, white liquid, boiling at 18 deg. below zero Fahrenheit.*

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ALTHOUGH EFFORTS *to enact an oil duty failed last week, Senator Thomas of Oklahoma, its chief proponent, was able to get through the Senate a resolution directing the Tariff Commission to investigate the oil situation. Within eight months, the commission is to report the relative costs of American and Venezuelan petroleum at Atlantic seaboard refineries.*

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EXPRESSING PREFERENCE *for a Federal Power Commission composed of competent men giving their full time to the question of power, Secretary of War Patrick J. Hurley, a member of the present commission, stated on March 24 that he is not in favor of the present plan of making up the body from cabinet officers "whose time is already taken up by the manifold character of their duties."*

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ANNOUNCEMENT *of an industrial gas called Electrolene, which is better than hydrogen in many applications, has just been made by the General Electric Company. Produced by feeding steam and city gas or other hydrocarbons into an electric cracking device developed by the company, this gas can be made at about a tenth of the cost of hydrogen.*

Agreement Reached on Allocation of Boulder Dam Power

Secretary Wilbur announces contracts are being let — Arizona, Nevada and Utah still oppose plan

A BOULDER DAM power agreement has been reached, according to an announcement of Secretary of the Interior Wilbur. It still appears likely, however, that Arizona and probably Nevada and Utah will oppose the plan which is closely similar to the tentative allocation previously backed by Secretary Wilbur. Apparently the administration is using California's internal understanding on power, following the earlier one on division of water, to force a showdown with the other states and to break the Boulder Dam deadlock. It is understood that Los Angeles and the power companies will contract for all power not otherwise taken, thus underwriting the project as required under the Boulder Canyon Act. This done, appropriations can be rushed through Congress, with Budget Bureau approval and possible executive impetus, for the work to commence.

But will it commence? Boulder Dam is still on paper. The minute a shovel is put in the ground, Arizona can get an injunction that will halt work until conflicting rights have been determined. Rather than postpone this day, the administration seems to be hastening it so that the legal battle, if any, can begin and reach an early end. While motion is being transmitted to the project through link after link of this ponderous chain of procedure, another conference between the states is being contemplated—perhaps in Washington, with Colonel Donovan presiding.

The new allocation divides Boulder Dam primary power on a percentage basis, as follows: Arizona, 18 per cent; Nevada, 18; metropolitan water district, 36; Los Angeles, 13; 11 applicant municipalities in California, 6; Southern California Edison and associate power companies, 9. In addition, the water district gets all it can use of the secondary power and unclaimed allotments for pumping water from the Colorado River for supply purposes. Whatever is left, and doubtless there will be something left while the project is getting established, is divided half and half between Los Angeles and the four power companies—the Southern California Edison Company, Southern Sierras Power Company, Los Angeles Gas & Electric Corporation, and San Diego Consolidated Gas & Electric Company.

Broad control is retained by the Secretary of Interior in shaping future transactions under the contract. Primary power is to be charged at 1.63 mills; secondary is to be determined later. The federal government will build and operate the power plant, cost to be allocated among contracting parties. In charge will be a director appointed by the Secretary of Interior. Contracting parties other than states must pay in trust for Arizona and Nevada compensation in lieu of taxes on machinery and equipment. A clause will be inserted in all contracts insuring distribution of power developed at Boulder Dam at a price considered by the Federal Power Commission as fair to all consumers.

Commission Now to Consider Other Colo. R. Projects

While the Boulder Dam Act lifted the ban of Congress against the granting of water power applications on the Colorado River and its tributaries, the Federal Power Commission has continued all of these projects under suspension until the entire situation can be appraised. The commission now has decided to proceed actively with the determination of the status of these projects. Licenses will be issued to constructed and run-of-stream plants where no controversy is involved and ninety days will be given for all applications on the main river and on the tributaries between Green River and the Gila to show why the project should be continued in good standing. It will be necessary for such applicants also to establish that their project will not interfere with Boulder Dam development.

Certain projects will be in direct conflict with the Boulder project. In that category the following apparently fall: No. 231, of James B. Girand, 130,000 hp., in Arizona; No. 238, of the City of Los Angeles, 800,000 hp., in Arizona and Nevada; No. 258, of the Southern California Edison Company, 1,200,000 hp., in Arizona and Nevada; No. 392, of G. Henry Stetson, 1,600,000 hp., in

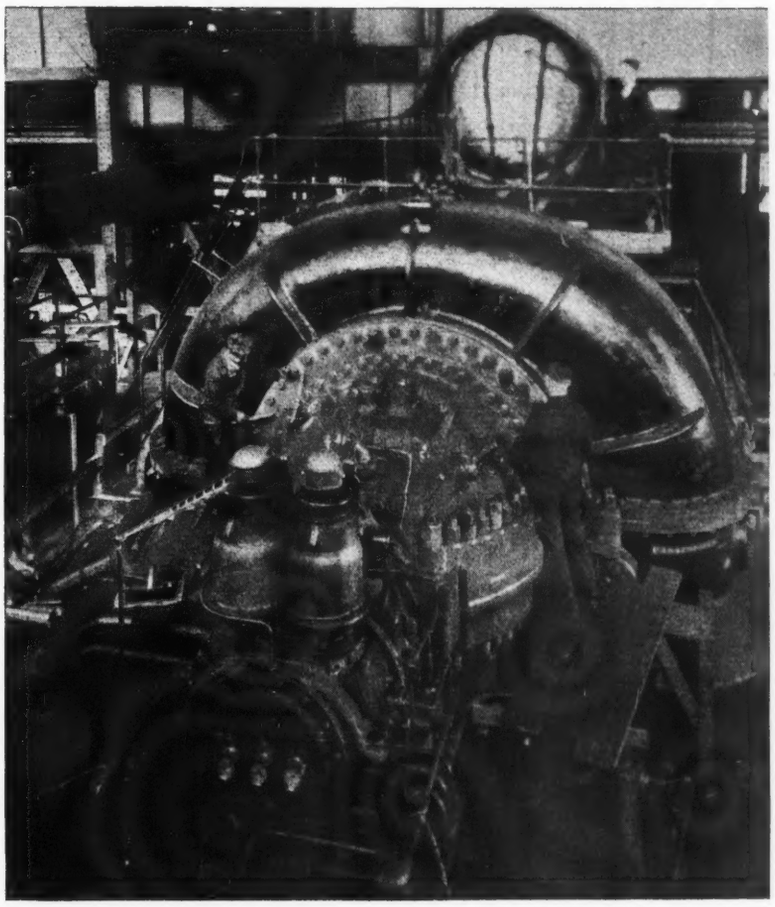
Arizona and Nevada; and No. 875, of the Board of Directors of State Institutions for Arizona, 340,000 hp. In addition, units of the following projects fall in that category; No. 59, Edward L. Beyard, 1,800,000 hp., in Arizona and Nevada; No. 111, Southern California Edison Company, 3,300,000 hp., in Arizona, Nevada and Utah; No. 265, Guy P. Mohler, 400,000 hp., in Arizona and Nevada; No. 660, Fred T. Coulter, 3,000,000 hp., in Arizona; and No. 837, Arizona Edison Company, 19,000 hp., at the mouth of the Gila River.

Other projects will have to establish that they will be able to market the product in competition with Boulder Dam power. The project of James B. Girand at Diamond Creek will have to be considered in connection with the proposed Bridge Canyon dam, which would flood out Diamond Creek. Special consideration also will be given the Flaming Gorge project of the Utah Power & Light Company, which the Commission, at one time, was prepared to license. Other proposed plants on the river which fall in one or the other of the categories mentioned are:

No. 30, Beckman & Linden Engineering Corporation, 200,000 hp., in Arizona and California; No. 158, Utah Power & Light Company, 100,000 hp., Green River; No. 230, James B. Girand, 130,000 hp., in Arizona; No. 279, Utah Power & Light Company, 800,000 hp., Green and Yampa Rivers; No. 301, C. N. Stannard, 57,000 hp., in Colorado; No. 391, G. Henry Stetson, 168,000 hp., in Arizona and Nevada; No. 500, the Western Colorado Power Company, 17,500 hp., Animas, San Miguel and Uncompahgre Rivers; No. 425, John L. Fish, 24,000 hp., Salt River; No. 524, A. E. Humphreys, 120,000 hp., Green River; No. 630, Miss Ida M. Butts, Eagle Creek; No. 647, City of Los Angeles, 200,000 hp., in Arizona and California; No. 661, Board of Directors of State Institutions for Arizona, 1,000,000 hp.; No. 668, Southern California Edison Company, 180,000 hp., in Arizona, California and Nevada.

Nos. 741 and 767, Joseph Whittman, 9,000 hp., Sabino, Bear, and Sycamore Canyons, Kirkland Creek, Santa Maria and Williams Rivers; No. 770, Board of Directors of State Institutions for Arizona, 750,000 hp., Colorado and San Juan Rivers; No. 808, Board of Directors of State Institutions for Arizona, 200,000 hp., Colorado River; No. 842, R. D. Webb, 3,300 hp., Lake Fork, Gunnison River; No. 854, A. E. Humphreys, 11,500 hp., Big and Little Brush Creek; No. 857, R. D. Webb, 26,000 hp., Henson Creek and Lake Fork Gunnison River; No. 924, Board of Directors for State Institutions, 70,000 hp., on the Little Colorado River; No. 953, James B. Girand, 6,000 hp., Salt River; No. 967, James B. Girand, 23,000 hp., Salt River; No. 968, James B. Girand, 33,000 hp., Salt River; No. 1,003, United Verde Copper Company, 82,000 hp., Little Colorado River; No. 1,062, Arizona Water Consumers District, 6,700 hp., Hassayampa River.

Testing the First Double-Deck Turbine



THE FIRST of the new type vertical compound turbine-generators is here shown being erected for test in the Schenectady Works of the General Electric Company. In this unique unit the 1,200-lb. high-pressure element and generator are mounted on top of the generator of the low-pressure element. The steam conditions are: 1,200 lb. at 750 deg. F. total temperature; boiler reheat to 750 deg.; and 1¼-in. absolute back pressure.

Two of these units, rated at 50,000 kw. each, have been ordered for the new addition to Station A of the Pacific Gas & Electric Company of San Francisco, Calif., plans for which were announced in *Power* for May 21, 1928.

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Report on Improvement of Tennessee River

In a report recently transmitted to the House from the War Department, the improvement of the Tennessee River from its mouth to Knoxville, calling for a navigable depth of nine feet, is recommended. The findings of the district engineer on the project would require the construction of low dams, to secure the necessary depth. The district engineer has estimated the cost at $74,709,000 to be spent over a period of ten years.

Although General Brown, chief of engineers, has generally approved the report of the district engineer, he believes that the adopted project should provide for the substitution of some of the low dams by high dams to be built primarily for power purposes. These structures would be built by a private interest under the provisions of the federal water-power act and would be equipped with locks for the use of the traffic on the river.

In case the power dams should be built before the improvement work is completed by the War Department, General Brown believes that those in charge of the power development should be paid an amount equal to the cost of the low level dams that otherwise would have been built. In submitting his recommendations to Congress, however, General Brown has expressed the opinion that he does not believe that the improvement of the river for navigation should be made contingent in any way upon the development of power. He also has taken the position that the approval by Congress should be final and should not be subject to periodic reconsideration, as has been suggested in the report of the Board of Engineers for Rivers and Harbors.

Trade and Industry Turn Upward

BY ROBERT M. DAVIS
Statistical Editor, McGraw-Hill Publishing Co.

THERE is little doubt but that the closing weeks of the first quarter of the year witnessed a distinct upward trend in general trade and industrial operations. Materially increased general construction contracts awarded in practically all sections of the country during the past few weeks, easing of money rates to the lowest point since 1923, improvement in the prices of farm staples, and trade and industrial betterment in one way or another in practically all sections of the country seem to give the brighest outlook since the year opened.

In spite of undoubted unemployment in most of the industrial centers, the sum total of industrial activity at the close of the first quarter as reflected by the various indices available is not really poor, suffering chiefly by comparison with the fore part of last year. No small part of the current unemployment is technological in nature, brought about by increasing efficiency in production in the last few years, and thus not wholly eliminated by a mere increase in industrial production. Not enough new commodities and forms of service have been brought out to take up the slack produced by the increasing efficiency.

"CURRENT BUSINESS is only fair, and collections are slow, but both are decidedly more favorable than we thought possible last November, and we fully expect a material improvement as the spring opens up." Such is the composite view of the country's business and industrial men as obtained by the writer during a 17,000-mile tour, just completed, which covered every section of the United States.

The business men recognize the fact that the wave of fear and apprehension which swept across the country immediately following the collapse of the stock market last October might easily have quickly led to chaos and the temporary destruction of the country's economic structure had it not been for the recuperative measures adopted by the financial and business interests under the direction and call of the federal authorities at Washington. Having been saved from this plunge into the abyss, the American business man is psychologically inclined to regard the present fair condition of production and trade as in a measure satisfactory. At any rate there is very little pessimism among business men as to the future—once the spring trade demands start.

THE GENERAL BUSINESS and industrial outlook for the second quarter as well as for the remainder of 1930 is distinctly favorable as the first quarter closes. With most of the industrial groups, including general construction, now definitely on the upgrade, and general trade expanding with the unusually late spring demands, there is a rosy hue to the horizon which has not existed since the recession set in last Fall.

Omitting the first quarter of the year, which was definitely one of adjustment to an entirely different economic plane, the year 1930 should stand out as one of unusual stability in American trade and industry. The last three quarters should witness an almost continuously improving state of business and industrial operations, in fact the closing months of 1930 should witness the opening of a period of business and industrial operations which will rival any period of prosperity which this country has known heretofore.

Condon Bill Killed

The New York State Assembly Committee on Labor and Industry has killed the Condon bill amending the labor law in relation to installation and inspection of steam power and heating plants. This extremely drastic bill, which sought to set up a compulsory code for the installation, alteration and equipment of steam power and heating plants, was prepared last year at the request of the New York State Association of Journeyman Plumbers and Steamfitters' Helpers. It failed of passage last year after a public hearing. Again introduced this year, without a public hearing being held upon it, it was killed in committee.

Seek to Extend Oklahoma Curb on Oil Output

An extension beyond April 1 of the present curtailment of oil production has been asked of the Oklahoma State corporation commission by Wirt Franklin, chairman of the operators' committee, which, according to a petition filed with the commission, has agreed upon further restriction. The petition states that Oklahoma is without available storage to take care of the excess production, and cites the overproduction in the United States, according to a report in the *United States Daily*.

The market demand in the state is 600,000 barrels, the petition says, while the potential production April 1 is 1,488,000 barrels a day. The average potential production for May was estimated at 1,715,000 barrels and for June at 1,869,700 barrels.

The operators asked the commission to curtail the production in the Oklahoma City field, which is said to be the most prolific, by 75 per cent.

Inspection of Used Boilers Urged in New York Bill

Under the provisions of a bill introduced in the New York Senate March 25 by John W. Gates, Republican of Chittenango, the state labor law is amended in relation to inspection of steam boilers, by providing among other things that no new or second-hand standard boiler shall be placed in operation until it has been inspected by a boiler inspector of the department or an authorized insurance company. It is further provided that on and after July 1, 1930, it shall be unlawful for any person, firm, partnership or corporation to operate under pressure in the state a steam boiler to which the section applies without a valid inspection certificate therefor.

New specifications are prescribed for a power boiler which is defined as one which exceeds the following dimensions: 16 in. diameter of shell, 42 in. inside length of shell, 20 sq.ft. total heating surface, and 100 lb. per square inch maximum allowable working pressure. Where these limits are not exceeded the vessel shall be known as a miniature boiler.

It is provided that where an inspector of the department of labor reports a boiler as operating with a current certificate and there has been no current report of inspection filed with the department the use of the steam boiler shall be immediately ordered discontinued until such time as the insuring company has filed with the department a current report of inspection.

Midwest Coal Conference Program Announced

Announcement has just been made of the program for the Midwest Coal Conference at Purdue University, Lafayette, Ind., April 9-11. Dedicated to the determination of newer and better methods of using Indiana and Illinois coals, the conference is sponsored by the Engineering Extension Department of Purdue University, the Coal Trade Association of Indiana and the Illinois Coal Bureau, representing Southern Illinois producers, in collaboration with the Fuels Division of the American Society of Mechanical Engineers, and will mark the beginning of a series of similar annual meetings.

The conference will open Wednesday afternoon, April 9, with an address of welcome by A. A. Potter, dean of engineering of Purdue University. Two main subjects are prescribed for this session, "Economic Justification for Greater Use of Illinois and Indiana Coals in the Middle West"; and "Availability, Classification and Suitability of Indiana and Illinois Coals for Various Uses." Presenting papers on this latter subject will be: Alex D. Bailey, chief of generating stations for the Commonwealth Edison Company of Chicago; W. D. Langtry, president, Commercial Testing

& Engineering Company, Chicago; and Professor C. H. B. Hotchkiss of the mechanical engineering department, Purdue University.

One of the main sessions of this year's conference will be devoted to a discussion and presentation of mechanical devices for burning Illinois and Indiana coals. This session is scheduled for Thursday morning, April 10, and will be opened by T. A. Marsh of the Chicago office of Combustion Engineering Corporation, whose paper represents the A.S.M.E. Fuels Division's contribution to the conference. He will be followed by representatives of industrial stoker manufacturers, who will present short papers. One feature of the conference closely connected with this session will be the exhibition of stoker and boiler units in actual operation.

Another outstanding feature of the meeting is the Friday morning session, April 11, for which the main topic is, "Reconditioning of Existing Plants to Burn Indiana and Illinois Coals Economically and Smokelessly." Among those expected to appear on this program are Frank A. Chambers, chief smoke inspector of Chicago; John Hunter, consulting engineer for the city of New York; and A. C. Willard, head of the department of mechanical engineering at the University of Illinois.

Joint Committee on Metals Meets in Detroit

The Joint Research Committee of the A.S.M.E. and A.S.T.M. on Effect of Temperature on the Properties of Metals held an interesting meeting at the Book-Cadillac Hotel, Detroit, Mich., on March 18, in conjunction with the spring group meeting of A.S.T.M. committees. At this meeting the committee decided to make a study of the high-temperature mechanical properties of cast- and wrought-carbon steels of customary composition. It is planned that these comparisons shall include the ordinary high-temperature tension tests and long-time or so-called creep tests.

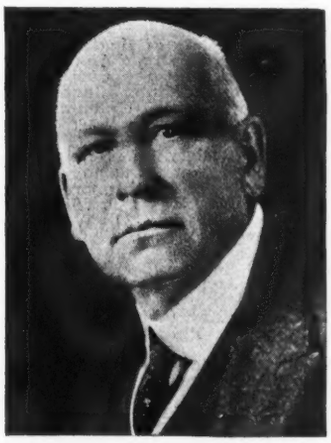
It was also decided to study the high-temperature properties of one of the high nickel-chromium (austenitic) steels, especially as regards effects of preliminary treatment, carbon content and microstructure. Discussion concerned the inclusion of a number of alloy steels in the program of future tests to be carried out for the committee, but no definite selections were made.

Attention was given to many of the details involved in the fatigue test program relative to carbon steel at different temperatures which is under way at the University of Illinois, Urbana, Ill., under the joint supervision of the committee and Prof. H. F. Moore. Consideration was also given to past work with the object of enabling the preparation of several reports which will quite probably be included in the annual report of the joint committee for presentation at the annual meeting of the society in June.

C. L. Newcomb, Noted Engineer and Pump Expert, Dies

Charles L. Newcomb, prominently identified with engineering and hydraulic work in New England, died March 13 at his home in Holyoke, Mass., after a long illness. Mr. Newcomb was considered an authority in mechanics and hydraulics and was widely known through his association with representative engineering societies as well as through extensive technical writing.

Born in West Willington, Conn., on



Charles L. Newcomb

Aug. 7, 1854, Mr. Newcomb was graduated from the Polytechnic Institute of Worcester, Mass., in 1880. Shortly afterward he was engaged to establish the first municipal electric lighting plant in the country at New Britain, Conn. He moved to Holyoke, Mass., in 1881 and soon became superintendent of the Deane Steam Pump Company. When the International Steam Pump Company obtained control of the Deane company, Mr. Newcomb was elected president and general manager of the reorganized concern. He was influential in bringing the Worthington Pump & Machinery Corporation to Holyoke with resultant control of the Deane Works. He continued as head of the Holyoke plant of Worthington until 1927, when he retired.

Mr. Newcomb was prominent in civic affairs in Holyoke, being elected councilman, alderman and a member of the city's first fire commission. He was a past vice-president of the American Society of Mechanical Engineers, a member of the Society of Naval Architects and Marine Engineers, National Foundrymen's Association, National Trades Association and the Engineers' Club of New York.

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NEW ORDERS for 881 steel boilers were placed in February, as reported to the Department of Commerce by 81 manufacturers comprising most of the leading firms in the industry, as compared with 942 boilers in January and 1,042 in February, 1929.

News of Canada

New boiler plant for Gatineau paper mill — Plans for Mississagi development — Toronto Iron Works plant completed

CONSTRUCTION of a boiler plant at its newsprint paper mill at Gatineau, Quebec, has been started by the Canadian International Paper Company. The plant will cost $1,000,000 and will be built to house five Kidwell boilers, of which four, with an aggregate of 52,000 sq.ft. of heating surface, will be installed at this time.

Plans for the boiler house were prepared by the engineering forces of the company in conjunction with the mill staff, and the boilers are being manufactured by Canadian Vickers, Ltd. The boiler house will be completed and ready for operation Oct. 1, when electric energy now being delivered by Gatineau Power Company for the generation of steam at the mill will be released for delivery to the Hydro-Electric Power Commission of Ontario under its contracts with Gatineau Power Company.

ANNOUNCEMENT was made in the Ontario Legislature recently that Ontario Hydro-Electric Power Commission arrangements for the development of the Mississagi River power sites as the chief source of supply for the ever-increasing electrical energy demands of the Sudbury district are rapidly reaching completion. The Mississagi sites will produce 100,000 hp. Immediate requirements in the Sudbury area from two places alone call for 70,000 hp., while in six months another big mine will be ready to take 20,000 horsepower.

For the development of these Sudbury district powers the government has voted $1,300,000, of which $1,000,000 goes to the actual Mississagi operations, and the remaining $300,000 goes for transformer stations and transmission lines. In discussing generally this new field of power development, Premier Ferguson stated that as time went on hydro power would be pushed more and more northward, and that other important powers—some lying north of the Transcontinental Railway—would be available for provincial acquisition.

THE RECENTLY completed plant of the Toronto Iron Works, Ltd., in Toronto, Ont., contains an up-to-date power house, erected at a cost of $50,000. This plant contains a compact control room providing primary and secondary switching and transformation for about 1,500 hp. There, too, are the synchronous motors which drive the air compressors for the main plant, where hundreds of direct-drive motors are applied to the different machines, and the huge transformer which steps down the voltage from 4,000 to 550. A feature of the switch room is the com-

plete set of delicate instruments that enable the superintendent to check at a glance phase balance, power factor, voltage and the load actually drawn. The switch room also contains master control of the main power circuits. All main lines from the power house are lead-covered underground cables, so that no yard wires are visible on the property.

Whiton Succeeds Brydon in Byllesby Company

Herbert S. Whiton has been appointed acting chief mechanical engineer of the Byllesby Engineering & Management Corporation, Chicago, Ill., to succeed H. Boyd Brydon, who resigned on March 15. The appointment was made public last week through an announcement of H. W. Fuller, vice-president in charge of engineering and construction of the Byllesby organization.

Mr. Whiton received the degree of bachelor of science in mechanical engineering from Harvard University in 1901. Early in 1905 he entered the employ of Stone & Webster as chief engineer of the power station of the Ponce Railway & Light Company at Ponce, Porto Rico. At the end of about two years he was made manager of the company, and in July 10, 1909, he was transferred to the Minneapolis General Electric Company as superintendent of power, having charge of all power stations and substations and the maintenance and operation of a 60,000 volt transmission line between St. Croix Falls, Wis., and Minneapolis, Minn. In June, 1923, he was transferred to the Chicago office of Byllesby Engineering & Management Corporation as assistant to Mr. Brydon.

Niagara Hudson Merger Authorized

The Public Service Commission of New York has granted the petition of the Niagara Hudson Power Corporation, authorizing it to acquire 450,000 shares, or about thirty per cent of the common stock of the Central Hudson Gas & Electric Corporation, serving Poughkeepsie, Newburgh, Kingston and other Hudson River municipalities.

The benefits to be had by interchange of current between the two companies and broader and better planning of distribution of electrical energy was shown by witnesses before the commission. It was stated that the Niagara Hudson company had some power sites which could be economically developed, while the Central Hudson company needs additional sources of electricity which can only be provided by increasing its steam plant capacity. The construction of an additional small steam plant, the evidence showed, could not be done economically. The development of larger sources of the Niagara Hudson company, however, would supply any deficiencies in the Central Hudson territory which needs additional energy.

COMING CONVENTIONS

American Society of Mechanical Engineers. Fiftieth Anniversary Celebration at New York City, Hoboken, N. J., and Washington, D. C., April 5-9, 1930. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers, District meeting at Springfield, Mass., May 7-10. Annual summer convention at Toronto, Canada, June 23-27. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Heating & Ventilating Engineers. Annual summer meeting at the Curtis Hotel, Minneapolis, Minn., June 23-25. Secretary, A. V. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Annual spring meeting at the Atlanta Biltmore Hotel, Atlanta, Ga., May 7-9. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at Haddon Hall, Atlantic City, N. J., June 23-27. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting at society headquarters in New York City, April 22-25. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual convention and iron and steel exposition at Broadway Auditorium, Buffalo, N. Y., June 16-20. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

International Railway Fuel Association. Annual meeting at the Hotel Sherman, Chicago, Ill., May 6-9. Secretary, C. T. Winkless, Room 700, LaSalle St., Station, Chicago, Ill:

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Oil and Gas Power Meeting, under auspices of A.S.M.E. Oil and Gas Power Division and Pennsylvania State College, will be held at State College, Pa., June 12-14. Chairman, L. H. Morrison, c/o *Power*, 10th Ave. and 36th St., New York City.

National Power Show. Held in connection with the International Textile Exposition at Mechanics Building, Boston, Mass., April 28 to May 3. For information, write to the New England Association of Commercial Engineers, 53 Devonshire St., Boston, Mass.

Second Plenary World Power Conference. Convenes at Berlin, German, June 16-25. Chairman of the American Committee, O. C. Merrill, Edmunds Building, Washington, D. C.

Personals

M. E. COOLEY, dean emeritus of the colleges of engineering and architecture at the University of Michigan; E. L. RYERSON of Joseph T. Ryerson & Son, Chicago; and JOSEPH W. ROE, professor of industrial engineering at New York University, have been appointed by the American Engineering Council to the Advisory Board of the Rosenwald Industrial Museum, in Chicago. As engineering advisors, they will aid in the organization of the Industrial Museum, now being planned under the direction of WALDEMAR KAEMFFERT.

OTTO VON KORIES, formerly chief engineer of the Holtville Ice and Cold Storage Company, Holtville, Calif., has accepted a position as chief power engineer and master mechanic with the Mazapil Copper Company, Conception del Oro., Zacatecas, Mexico.

KARL TAYLOR COMPTON, head of the department of physics at Princeton University, has been chosen president of Massachusetts Institute of Technology, Cambridge, Mass., to succeed DR. SAMUEL W. STRATTON, who will become chairman of the executive committee and the corporation of the institute.

J. D. Ross was reappointed superintendent of municipal lighting for the City of Seattle, Wash., and W. D. BARKHUFF was reappointed city engineer, by Mayor Frank Edwards, who was returned to office at the election held recently in that city.

D. C. GREEN, who relinquished his duties as vice-president and general manager of the Utah Power & Light Company more than a year ago to associate himself with the New York office of the Electric Bond & Share Company, has been elected a vice-president of Electric Bond & Share.

G. E. WHITTLESEY, who has been superintendent of distribution for the Pittsfield Electric Company, Pittsfield, Mass., has been transferred to the engineering department of the Western Massachusetts Companies, with offices in Pittsfield. LAWRENCE D. BIGELOW, who has been superintendent of underground wires for the United Electric Light Company of Springfield, has succeeded to the position in Pittsfield formerly held by Mr. Whittlesey.

E. G. ALLEN, formerly advertising representative at the South Philadelphia works of the Westinghouse Electric & Manufacturing Company has resigned his position to assume charge of advertising at the Fuller-Lehigh Company, Fullerton, Pa. Mr. Allen, a graduate mechanical engineer, became identified with the Westinghouse company in 1920, starting as stoker engineer and later transferring to the advertising department.

Business Notes

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., reports that the year 1929 was the best in the history of the company in volume of orders received, shipments billed, total profits and earnings per share of common stock. Orders received during 1929 were $445,802,519, compared with $348,848,512 in 1928; sales billed amounted to $415,338,094, as against $337,189,422 for 1928, and net income from sales totaled $49,395,896, in comparison with $39,661,230 in 1928. Profit available for dividends amounted to $67,289,880, equivalent to $8.97 a share on 7,211,481 shares of common stock, compared with $7.15 a share for 1928.

PHOENIX MANUFACTURING COMPANY, Joliet, Ill., announces that at its annual board of directors meeting John W. Kiser, formerly president, was made chairman of the board; Edward N. Gosselin, formerly vice-president and general manager was elected president; and M. F. O'Conner, formerly Eastern sales and export manager, was made a vice-president.

REEVES PULLEY COMPANY, Columbus, Ind., has opened a sales and service branch office in the Euclid-Windsor Building, 5005 Euclid Ave., Cleveland, Ohio. D. C. Batterson and J. H. Gepfert are in charge of the new office.

THE BIGELOW COMPANY, New Haven, Conn., announces the election of Gustav Welter and Paul M. Fleming as assistant vice-presidents and Herbert W. Horton, as assistant secretary and purchasing agent. W. R. Holmes has been appointed sales manager of the company's New York office to succeed Thomas C. Vincent, Jr., who resigned.

LEEDS & NORTHRUP COMPANY, Philadelphia, Pa., announces the removal of its Cleveland, Ohio, office to larger quarters at 1941 Union Trust Building.

RELIANCE ELECTRIC & ENGINEERING COMPANY, Cleveland, Ohio, has appointed C. Brigham Allen, Jr., district sales representative of the Philadelphia office.

BAILEY METER COMPANY, Cleveland, Ohio, has appointed H. M. Hammond manager of sales and engineering. Mr. Hammond's former position was sales manager of the company.

SANDVIK CONVEYOR MANUFACTURING COMPANY, Newark, N. J., has opened an office in Chicago, Ill., at 180 North Michigan Avenue, in charge of Morton Fries.

THE STEPHEN COMPANY, Cleveland, Ohio, announces the addition of the Unipulvo system of pulverized fuel firing, made by the Strong-Scott Manufacturing Company of Minneapolis, Minn., to its line of power plant equipment.

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With the SOCIETY SECTIONS

A.S.M.E., Metropolitan Section. Meeting sponsored by the Fuels Division of the A.S.M.E. on April 3 at 8 p.m., at the Engineering Societies Building, 29 West 39th St., New York City.

A.S.M.E., Plainfield Section. Joint meeting with the Plainfield Engineers Club at Masonic Temple, Elizabeth, N. J., on April 3. Subjects: "Some Aspects of the Petroleum Industry of Interest to Mechanical Engineers," by R. T. Haslem, vice-president of the Standard Oil Development Company, and "Stresses in Thick Tubes Subjected to High Pressures and Temperatures," by E. W. Luster, assistant manager of the General Engineering department of the Standard Oil Development Company.

A.I.E.E., Niagara Frontier Section. Meeting at Niagara Falls Power House No. 2 on April 18. Subject: "Use of Regulators in Industry," by J. H. Ashbaugh, regulator engineer of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Midwest Bituminous Coal Conference. Held under the direction of the Engineering Schools of Purdue University, Coal Trade Association of Indiana and Illinois Coal Bureau, at Lafayette, Ind., April 9-11. Chairman, W. A. Knapp, Purdue University, Lafayette, Ind.

New England States Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the State Armory, Salem, Mass., June 19-20, 1930. Secretary, E. S. Daniels, 113½ Bridge St., Salem, Mass.

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Trade Catalogs

METERS—A summary of the use of various meters in the power plant is contained in illustrated Bulletin No. 251 just issued by the Builders Iron Foundry, 9 Codding St., Providence, R. I.

FEED-WATER TREATMENT—Standardized feed-water treatment with centralized control is described in a recent publication of the National Aluminate Corporation, 6216 West 66th Place, Chicago, Ill. Attractively illustrated and printed, this 16-page bulletin presents three plans of controlled treatment of water.

HEATING—Modernization of obsolete heating systems by use of Webster Sylphon attachments is fully described in a 16-page illustrated publication, Bulletin B-800, of Warren Webster & Company, Camden, N. J. The booklet contains much valuable data on heating systems.

CIRCUIT BREAKERS—The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has published a new, illustrated, 20-page circular, No. 1705-B, on Type CL carbon circuit breakers. The booklet includes a history, construction details and installation photographs of the breakers.

JET HEATERS—Bulletin No. 3-A of the Schutte & Koerting Company, Philadelphia, Pa., completely describes the SK line of steam-jet heaters for water and other liquids. Many illustrations in color show construction details and applications of these heaters.

STOKERS—Construction, operation, theory of combustion and typical operating results with all types of Taylor stokers, stoker drives and ash-discharge mechanisms are fully described and illustrated in color in the new stoker catalog just issued by the American Engineering Company, Philadelphia, Pa.

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Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.20 @ $2.30
Kanawha	Columbus	1.35 @ 1.50
Smokeless	Cincinnati	1.75 @ 2.25
Smokeless	Chicago	1.75 @ 2.25
S. E. Kentucky	Chicago	1.40 @ 1.60
Steam	Pittsburgh	1.40 @ 1.65
Gas Slack	Pittsburgh	.90 @ 1.10
Big Seam	Birmingham	1.35 @ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.70 @ 3.00
Barley	New York	1.40 @ 1.50

FUEL OIL

New York—Mar. 27, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5.5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Mar. 21, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.520 per bbl., or 42 gal.; 26@28 deg., $1.620 per bbl.; 28@30 deg., $1.720 per bbl.; 30@32 deg., $1.77 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 37@40 deg., distillate, 4.98c. per gal.

Pittsburgh—Mar. 18, f.o.b. local refinery, 30@34 deg., fuel oil, 4.5@4.75c. per gal.; 36@40 deg., 4.75c.

Philadelphia—Mar. 11, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati—Mar. 25, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Mar. 14, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 85@90c. per bbl.; 26@30 deg., $1.05@$1.10 per bbl.; 30@32 deg., $1.20@$1.25 per bbl.

Boston—Mar. 24, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.2c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Mar. 22, f.o.b. local refinery 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Galt—Galt Sanitary Dist., is receiving bids for the construction of a pumping plant in connection with sewage treatment plant. C. W. Deterding, Jr., Courthouse, Sacramento, is engineer.

Calif., Oakland — East Bay Utility District, awarded contract for equipment for Claremont and Pleasant Valley pumping plants to Byron-Jackson Pump Co., 6th and Carlton Sts., Berkeley, also equipment for Pine St. pumping plant to United Iron Works, 580 2nd St., Oakland.

Colo., Devine — Ford, Bacon & Davis, 39 Broadway, New York, N. Y., Engrs. are receiving bids for the construction of a 5,000 hp. gas compressor station at Amarillo-Denver natural gas pipe line here for Colorado-Interstate Gas Co., subsidiary of Cities Service Co., 60 Wall St., New York. Estimated cost $600,000.

Conn., New Haven—New York, New Haven & Hartford R.R. Co., let contract for the construction of a central heating plant to Tredennick Billings Co., 10 High St., Boston, Mass. Estimated cost $195,000.

Conn., New London—City plans pump house extensions, additional reservoir, and mains in connection with waterworks. Estimated cost $80,000. G. E. Watters, City Hall, is engineer.

Idaho, Boise—W. E. Pierce, awarded contract for the construction of an 11 story hotel at 8th and Bannock Sts. to Hansen Construction Co., Failing Bldg., Portland, Ore. Estimated cost $650,000. Steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc. will be installed.

Ill., North Chicago—U. S. Veterans' Bureau, Arlington Bldg., Washington, D. C., will receive bids until Apr. 29 for the construction of a group of buildings including boiler plant, etc. at U. S. Veterans' Hospital here.

Ky., Barbourville—Knox-Jellico Mining Co., acquired 4,000 acres of coal lands and plans the installation of a 40 car per day capacity mining and loading plant. Estimated cost $500,000.

La., New Orleans — Sewage & Water Board, G. G. Earl, Gen. Supt., will receive bids until May 21, for extension to drainage pumping station No. 3.

Mass., Brighton (sta. Boston)—Harvard University, A. L. Lowell, Pres., is receiving bids for the construction of a 75 x 100 ft. power house at Harvard Medical School here. Densmore, LeClear & Robbins, Park Sq. Bldg., Boston, are architects and engineers.

Mass., East Boston (Boston P.O.)—Dept. of Public Works, Boston, is having preliminary plans prepared for the construction of a pumping station for Outfall sewer on Porter St. here. Estimated cost $50,000. T. F. Bowes, City Hall, is engineer.

Mass., Reading—Bd. of Selectmen, plans extensions and improvements to municipal lighting plant and service station. Private plans.

Mich., Grand Rapids—Consumers Power Co., 129 Pearl St., J. A. Cleveland, Distr. Mgr., awarded contract for changing all equipment from 30 to 60 cycle current to Stevens & Wood, 60 John St., New York, N. Y. $7,500,000 appropriated for this district. Will require four years to complete.

Minn., Minneapolis—Northwestern Bell Telephone Co., F. Bracelin, Mgr., 1208 Hodgson Block, awarded contract for the construction of a 24 story telephone exchange building at 5th St. and 3rd Ave. S. to Piper, Drake & Schumacher, 316 Baker Bldg. Estimated cost $2,500,000. Steam heating system, etc. will be installed.

N. J., Trenton—State Bd. of Education, State House, received lowest bid for the construction of power house at State Teachers College, Hillwood Lakes, from J. H. Morris Co., 211 N. Montgomery St., Trenton. $70,884.

S. C., Charleston—Treasury Dept., Office of J. A. Wetmore, Acting Supervising Architect, Washington, D. C., will receive bids until Apr. 16 for the installation of wells, pumping plant, etc. at U. S. Quarantine Station here.

Tex., Caldwell—City, c/o C. E. Cromartie, Mayor, is having plans prepared for waterworks improvements including electrifying steam pumping plant and new reservoir. J. Rady, Waco, is consulting engineer.

Tex., Edna — Central Power & Light Co., Frost Bldg., San Antonio, is receiving bids for the construction of a 60 ton ice plant, here. Estimated cost $40,000. J. Marriott, Frost Bldg., San Antonio, is engineer.

Tex., Galveston—Gulf Colorado & Santa Fe Ry. Co., is having preliminary plans prepared for the construction of an 8 story union depot and office building including steam heating, ventilation and refrigeration systems, boilers, elevators, etc. Estimated cost $600,000. F. Merritt, is chief engineer.

Tex., Goose Creek—American Service Co., c/o J. H. McKinney, will build a 25 ton ice plant including 100 ton storage vault at Highlands. Estimated cost $60,000. Private plans. Work will be done by owners forces.

Tex., Hidalgo — Hidalgo County Irrigation Dist. 12, c/o N. L. Reyna, Pres., Edinburg, voted $5,500,000 bonds the construction of a pumping plant, reservoirs, etc. in connection with proposed irrigation project.

Wash., Anacortes—City plans an election Apr. 22 to vote $400,000 bonds for the construction of a water supply system including auxiliary pumping station at Whistle Lake.

West Virginia—West Virginia Power & Transmission Co., subsidiary of West Pennsylvania Electric Co., 50 Broad St., New York, N. Y., has made application to Public Service Commission for permit to construct hydro-electric plants along Cheat River at Morgantown, Kingswood, Albright, Bruceton Mills, Rowlesburg, St. George, Parsons, Hendricks, Davis, Thomas and Elkins. Estimated cost approximately $15,000,000.

Ont., Toronto—Toronto Electric Comrs., 225 Yonge St., will receive bids until Apr. 3 for the construction of a 2 story electric substation at Yonge St. and Glengrove Ave. Estimated cost $1,250,000. P. C. Hart, 225 Yonge St., is chief engineer.

Equipment Wanted

Air Compressor — Ventnor, N. J. — Bd. of Council, City Hall, will soon receive new bids for a portable air compressor for street department. $1,500. Former bids rejected.

Boilers—New Orleans, La.—U. S. Engineers Office, Second New Orleans District, ft. of Prytania St., will receive bids until Apr. 10, for one battery of three steam boilers for installation on U. S. Steamboat H. S. Douglas.

Boilers and Stokers—Kansas City, Kan.—Bd. of Public Utilities, c/o C. Lowder, Secy., will receive bids until Apr. 9 for one 1200 hp. boiler and stokers for power plant.

Engine, Motor, Pumps, Etc.—Star City, Ark.—Waterworks Improvement Dist. No. 3, will soon receive bids for a 10 hp. Diesel engine, one 10 hp. electric motor and two 250 g.p.m. pumps, etc. for proposed waterworks improvements.

Pump—Florida, Tenn.—State Road Dept., R. W. Bentley, Chn., will receive bids until Apr. 8 for one 80 g.p.m. triplex high pressure force pump.

Pumping Equipment—Roosevelt, Okla.—City will soon receive bids for pumping equipment, etc. for proposed waterworks improvements. $20,000.

Pumping Equipment—Crescent, Okla.—City will soon receive bids for pumping equipment, etc. for proposed waterworks improvements. Estimated cost $20,000.

Pumping Equipment—Smithville, Tex.—City plans to purchase pumping equipment for proposed waterworks improvements. Estimated cost $40,000.

Pumping Unit—Mission, Tex.—Santa Monica Water Control & Improvement Dist., plans an election Apr. 12 to vote $50,000 bonds for erection and installation of a pumping unit, etc. in connection with irrigation work.

Pumps—New Brunswick, N. J.—City plans the installation of three electric motor driven pumps and one gasoline driven centrifugal pump for proposed waterworks improvements. Estimated cost $60,000.

Pumps—Venter, N. J.—Bd. of Council, plans to purchase automatic electric pumps, etc. for proposed waterworks system. Estimated cost $75,000.

Pumps and Motors—Bruceton, Tenn.—City will receive bids until Apr. 10 for two deep well pumps and motors, etc. for proposed waterworks system. Estimated cost $45,000.

Transformers, Etc.—Watonza, Okla.—City, M. S. Siree, Supt., is in the market for ten 25 kw. transformers, etc.

Industrial Projects

Calif., Los Angeles—Dry Ice Corp., c/o Austin Co. of California, 777 East Washington St., Engrs., awarded contract for the construction of a 1 story, 100 x 147 ft. factory at 2618 Pitt St., to H. M. Baruch Corp., 1015 Lincoln Bldg. Estimated cost $30,000.

Calif., Oakland — Barrow Corp., Lynchburg, Va., awarded contract for the construction of a 2 story, 80 x 106 ft. factory and storage building here to The Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $40,000.

Conn., Hartford—Superior Spring & Mfg. Co., 373 Washington St., is haying revised plans prepared for a 2 story, 60 x 130 ft. factory on Washington St. Estimated cost $65,000. G. L. Dunkelberger, 721 Main St., Archt. C. Schultz, 118 Sheffield Ave., is engineer. Former bids rejected.

Mass., Ashland — Warren-Telechron Co., awarded contract for a 2 story addition to factory to H. L. Hauser Building Co., 263 Summer St., Boston.

Mass., Athol—N. D. Cass, 62 Canal St., is having plans prepared for a 3 story, 60 x 100 ft. toy manufacturing plant. Estimated cost $50,000. Private plans.

Mass., Boston—W. D. Cashin Co., 35 Hartford St., is having plans prepared for a 1 story factory for the manufacture of boilers and equipment. Estimated cost $50,000. Private plans.

Minn., Blue Earth — Minnesota Valley Canning Co., Le Sueur, will build canning plant and power plant here. Estimated cost $450,000. Work will be done by day labor. This corrects report in Mar. 4 issue.

N. H., Laconia—Scott & Williams Inc., 266 Union Ave., manufacturers of knitting machinery, awarded contract for a 4 story, 65 x 270 ft. factory to Temple & Crane, 80 Federal St., Boston, Mass. Estimated cost $100,000.

N. J., Keasby—D. Wortmann, 116 Livingston Ave., New York, N. Y., Archt., is receiving bids for a 1 story, 80 x 130 ft. addition to factory here for General Ceramics Co. Estimated cost $50,000.

N. J., Linden—Commercial Steel Equipment Co., 1024 Elizabeth Ave., is having plans prepared for a 1 story factory. Estimated cost $40,000. A. J. Silberstein, 868 Broad St., Newark, is architect.

N. J., Newark—Newark Special Tool & Machine Co., 51 Lawrence St., will build a 1 story, 90 x 110 ft. factory at 87-95 St. Francis St. Estimated cost $40,000. M. S. Silberstein, 964 Broad St., is architect. Work will be done by separate contracts.

N. J., Perth Amboy—Standard Underground Cable Co., H. B. Wodtke, awarded contract for the construction of a plant to Public Service Production Co., 80 Park Pl., Newark. Estimated cost $200,000.

N. J., South Nyack—B. F. McGuire, 416 Cedar Lane, Teaneck, Archt., will receive bids about June 1 for the construction of a 6 story hotel, etc. including steam heating, ventilation and refrigeration systems, boilers, elevators, etc. on River Rd. for Nyack Development Corp., c/o architect. Estimated cost $1,000,000.

N. Y., Buffalo—Buffalo Foundry & Machine Co., 1543 Fillmore Ave., awarded contract for a 1 and 2 story, 103 x 137 ft. machine shop at Fillmore near Ferry to Crooker, Carpenter & Skaer, Crosby Bldg. Estimated cost $79,000.

O., Waynesboro — National Fireproofing Co., Fulton Bldg., Pittsburgh, Pa., plans the construction of a 1 story, 100 x 150 ft. factory for the manufacture of clay products, building tile, etc. here. Estimated cost $50,000 to $75,000. Private plans.

Va., Richmond—American Can Co., 230 Park Ave., New York, N. Y., plans the construction of a can factory, here. Estimated cost $1,000,000. Private plans.

Ont., Ottawa — Noffke, Morni & Sylvester, Metcalfe St., Archts., will soon receive bids for the construction of a 4 story brewery for Capital Brewing Co. Ltd., Wellington St. Estimated cost $250,000. Vats, electric refrigerator, cooling rooms and central heating plant, etc. will be installed.

Ont., Walkerville—Canadian Bridge Co. Ltd. Walker Rd., plans the construction of a 1 story 240 x 310 ft. addition to plant for transmission line tower manufacture. Estimated cost $100,000. Private plans.

Quebec—International Paper Co. Ltd., 100 East 42nd St., New York, N. Y., is having plans prepared for extensions and improvements to hydro-electric plant and paper mill at Delhause. $1,500,000, also plans a boiler plant at Gatineau. $1,000,000. Work will be done by separate contracts. Boiler and equipment contract awarded.